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Air Force Space Command

**SPACE AND MISSILE SYSTEMS CENTER
STANDARD**

**HUMAN COMPUTER
INTERFACE
DESIGN CRITERIA**

**VOLUME 2
SPACE SYSTEM OPERATIONS DISPLAYS**

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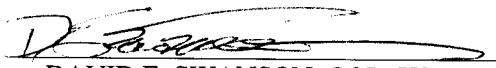
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FOREWORD

1. This standard defines the Government's requirements and expectations for contractor performance in defense system acquisitions and technology developments.
2. This revised SMC standard comprises the text of The Aerospace Corporation report number TOR-2010(8591)-3, Volume 2, entitled *Human Computer Interface (HCI) Design Criteria Volume 1: Display Conventions for Space System Operations* which contains the following major changes from HM-RB-2001-1:
 - Deleted FOREWORD describing the obsolete Human Machine Interface Review Board
 - Updated reference documents
3. Beneficial comments (recommendations, changes, additions, deletions, etc.) and any pertinent data that may be of use in improving this standard should be forwarded to the following addressee using the Standardization Document Improvement Proposal appearing at the end of this document or by letter:

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4. This standard has been approved for use on all Space and Missile Systems Center/Air Force Program Executive Office - Space development, acquisition, and sustainment contracts.



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Change Record

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| 1 | Overview | Updated JTA reference to Volume 1 of this document |
| 3.1.4 | | Removed reference to Joint Technical Architecture (JTA) |
| 6.3.7 | | Removed reference to “Developer’s Style Guide” |

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1. Overview

The Human Machine Interface (HMI) Conventions Document has been developed under the direction of and with oversight from the United States (US) Air Force Space Command (AFSPC). It provides recommended HMI conventions for use in designing satellite operations systems. The intent is to provide sound HMI practices for either: satellite operations programs, which are planning upgrades, or for new programs, which employ operator workstations to perform any satellite operations activities.

The conventions described in this document were developed to be as flexible as possible, while attempting to ensure commonality between satellite operations systems. Every effort has been made to maximize the incorporation of basic industry standards, existing/proven program designs, and derive specific conventions where necessary to meet unique domain requirements. The conventions are based upon the latest Air Force Satellite Control Network (AFSCN) Employment Concept (Department of the Air Force, 1996) and the Functional Task Analysis (FTA) (Lockheed Martin Mission Systems, 1998). The FTA captures specific tasks, operator decisions, and screen content determined to be necessary to accomplish each task. These conventions are also consistent with Volume 1 of this document and the American Institute of Aeronautics and Astronautics (AIAA) Recommended Practice for Human-Computer Interface for Space Systems Operations (HCIS) [BSR/AIAA R-023A-1995, 1995].

1.1 Conventions Document Organization

The following list summarizes the organization and content of this document:

- Section 1, Overview; provides an introduction to the intended use of these conventions, definitions of the individual functional areas (domains) in satellite operations, and high level general HMI design principles.
- Section 2, Operator Interaction; presents design guidance for operator interaction with the computer.
- Section 3, Screen; presents conventions for the screen layout, definition of each zone, including guidance on presentation of alert information, and guidance on the application and use of color.
- Section 4, Window; presents design guidance for window layout and window elements, including title bars, menus, and other window components.
- Section 5, Help; presents guidance for providing access to multiple levels and kinds of on-line help.
- Section 6, Domain Specific Conventions; presents guidance specific to application of the conventions in domain operations.

1.2 Domain Overview

The following sections provide an overview of the functional areas of responsibility (domains): Contact Operations, Mission Planning, Orbit/Attitude Management, Engineering Analysis, Mission

Payload Operations, and Operations Support. These domains contain tasks or activities, which are considered to be function or position specific. Functions have been organized into these domains for ease of describing display conventions in this document. Depending on a system's operational concept, functions may be combined into one or more positions or they may be allocated across positions.

1.2.1 Contact Operations

The Contact Operations Domain consists of satellite support activities to include: execution of individual satellite contacts, configuration/deconfiguration of resources, execution of the satellite support plans (SSPs), in-procedure anomaly resolution, status reporting, and coordination with external agencies as required.

1.2.2 Mission Planning

Mission Planning is responsible for all tasks associated with non-real-time scheduling and preparation of support to meet mission requirements of a satellite constellation. This includes keeping track of schedule-impacting, long-term satellite control network outages, maintaining support requirements catalogs, preparing long-term support schedules for satellite constellation, and preparing selected SSPs.

1.2.3 Orbit/Attitude Management

Orbit/Attitude domain activities are related to maintaining each satellite's correct orbit (path through space) and attitude (orientation with respect to the Earth, Sun or other celestial objects). This includes developing orbit and attitude state vectors, generating ephemeris/event products, generating orbit stationkeeping, and generating attitude maintenance maneuvers. Activities also include producing station visibilities, Radio Frequency Interference (RFI) conjunction projections, predictions of close approach to other space objects and interfacing with Inter-Range Operations (IRO).

1.2.4 Engineering Analysis

Satellite Engineering provides the technical details necessary to operate complex satellite systems. This includes developing, validating, and maintaining a library of SSPs, monitoring the state of health of assigned satellites, developing anomaly resolution plans/satellite safeing procedures, and assisting in out-of-procedure anomaly resolution.

1.2.5 Mission Payload Operations

The tasks required to perform Mission Payload Operations include data receipt, processing, analysis and dissemination. Although the processing and analysis functions relate primarily to the mission data itself, unique display requirements may also exist for monitoring and controlling payload sensors and on-board processes. Because both of these areas are highly mission unique, the intent is to identify conventions that are common among programs and can be applied to all equally. The conventions are therefore at a higher level than the other domains. For most functions, the common conventions, as defined, are sufficient. The conventions captured for this document reflect the review of payload operations' screens from Global Positioning System (GPS), Defense Satellite Communications System (DSCS), and Space Based Infrared System (SBIRS).

1.2.6 Operations Support

Operations support includes functions, which are required to maintain operations, but which are not directly related to operational control of satellites. The areas included in this domain are: system administration, security management, database management, and training/evaluation for satellite operations.

1.3 Design Principles

In general, once a set of design conventions has been chosen, it should be followed consistently within the application and across applications when used by the same operator position(s). Not all conventions can be used interchangeably. Care must be taken to select the tools and technologies which use complimentary conventions. For example, buttons with the same behavior should appear the same (See Developer's Style Guide) and the placement of tool bars (Para. 3.1.4, Toolbar) should be consistent when presented to an operator.

Listed below are principles to be applied to satellite operations screen design:

- Minimize the number of windows that an operator must access to perform a task.
- Minimize operator actions that must be performed.
- Have alternative methods for data entry and selection (i.e., have at least two methods for inputting information, executing actions, and making selections).
- Minimize operator errors.
- Maximize use of default values.
- Utilize option menus and combo boxes to reduce data entry errors.
- Utilize automatic error checking procedures as much as possible.
- Maximize reuse and efficiency of windows.
- Limit information displayed to ensure a clutter-free appearance.
- Present information in expected locations, e.g., left to right, top-to-bottom orientation.
- Present information in a consistent format.
- Minimize pointer and eye movement requirements.
- Present information simply and in a functionally-organized manner.
- Aggregate and group functionally related fields.
- Provide clear indications of interrelationships, e.g., use borders or frames to delineate groups.

- Use color purposefully for coding, i.e., conveying information to the operator, not for decoration.
- Use plain, simple language, limit use of acronyms and abbreviations.
- Provide an intuitive way to navigate through the system.
- Establish acceptable refresh rates for indicating status and monitoring processes.
- Notify operator of significant system/status changes, as in alert messages.
- Present alert messages in a timely, unambiguous manner.
- Require operator acknowledgment for critical notifications.

2. Operator Interaction

This section identifies conventions and display design guidance for operator interaction with the computer. Domain unique conventions are found in Para. 6, Domain Specific Conventions.

2.1 Pointing Devices

(Ref: Para. 3.1.2.3 of ANSI/AIAA R-023-1995 HCISSO and Para. 2.1.3 of the User Interface Specifications for the DII, v. 3.0, 1998).

2.1.1 Mouse Keys

The following default mouse key assignments are provided in most operating environments. Key assignments can be defined to standardize behaviors across applications if necessary.

- For a two button mouse:
 - Left button (button 1) - selects, moves, and makes the selected field or window the active field or window.
 - Right button (button 2) - pop-up menu, additional information, Help.
 - <Shift> button 1 - adjusts.
- For a three button mouse:
 - Left button (button 1) - selects, moves, and makes the selected field or window the active field or window.
 - Middle button (button 2) - adjusts.
 - Right button (button 3) - pop-up menu, additional information, Help.

2.1.2 Touch Interactive Devices

Touch interactive devices permit a user to control movement of a pointer and select options with a finger or another device, such as a light pen. While not demonstrated in this effort, touch interactive devices can only be used when limited choices are presented at any particular time and the choices for selection have sufficient separation to prevent operator error in selection.

2.2 Voice Input

Voice input provides a natural method of inputting commands or directions and allows for no hands operations. Voice input requires a specific lexicon, feedback confirming spoken entries, and an alternative entry method. This technology is not recommended for mission critical and time critical directions which could be incorrectly interpreted, thus causing damage to the system or unacceptable degradations or failures. This technology was not demonstrated in this effort. See Para. 3.3, Alternative Input/Output (I/O) Devices, of the DoD HCI Style Guide, for design considerations when choosing this technology.

2.3 Navigation Keys and Techniques

Several techniques exist for experienced users to rapidly (rapidly and consistently) access certain functions or actions. The following are defined in greater detail below:

- Function keys.
- Accelerator keys.
- Mnemonics.

The same function keys, accelerator keys, and mnemonics (shortcut or hot keys) are not to be used for different actions within a domain; or across domains/applications if assigned to a single operator position. This eliminates the chance of operator error. Note: Domain specific shortcut or hot keys are defined in Para. 6, Domain Specific Conventions.

2.3.1 Function Keys

Table 2.1 presents default and reserved function key definitions that may be used in either Motif or Windows design.

Table 2.1. Default Function Key Definitions

| Function Key | Function/Action |
|--------------|---|
| F1 | Help – Access to Help Menu |
| F6 | Navigates to next pane of active window |
| F7 | Reserved |
| F8 | Reserved |
| F9 | Reserved |
| F10 | Navigates to/from a menu bar |
| F12 | Print |

2.3.2 Accelerator Keys

Accelerator keys consist of a modifier key (<Shift>, <Alt>, or <Ctrl>) and some other key. Table 2.2 present accelerator keys that may be used in either Motif or Windows design.

Table 2.2. Default Accelerator Key Definitions

| Accelerator Key | Function/Action |
|-----------------|------------------------------|
| <Shift> F1 | Context Sensitive Help |
| <Alt> F4 | Closes current active window |
| <Ctrl> P | Print |

2.3.3 Mnemonics

Mnemonics are identified by underlining a single character. Normally mnemonics are used in menu titles and menu options. All menu titles and options have a mnemonic. When the construct (i.e., menu, button, or other) has input focus, keyboard entry of the mnemonic executes the selection. Table 2.3 presents mnemonics that may be used in either Motif or Windows design.

Table 2.3. Default Mnemonic Definitions

| Mnemonic Key | Function / Action |
|--------------|-------------------|
| F | File menu |
| H | Help menu |
| S | Save |
| X | Exit |

2.4 Screen/Window Navigation

There are several methods for moving around in a screen and/or between windows. Use the method necessary to improve operator efficiency in performing specific tasks/operations.

2.4.1 Display Window Navigation

(Ref: Para. 3.2.5.2 of ANSI/AIAA R-023-1995 HCISSO).

Listed below are conventions specific to this method:

- Point and click
- Push Buttons
- Menu actions (availability is position dependent) using point and click, accelerator keys function keys, and mnemonics

2.4.2 Keyboard Navigation

(Ref: Para. 3.2.5.1 of ANSI/AIAA R-023-1995 HCISSO).

Listed below are conventions specific to this method:

- Arrow keys
- Tabs
- Command Entry

(See Command Window, Para. 9.1.7, User Interface Specifications for the DII, v. 3.0, 1998).

This capability is generally reserved for specialized functions, such as those found in System Administration. Note: Operator access to performing command entries through a command window is limited through system access privileges.

2.5 Use of Multiple Windows On A Single Screen Display

Simultaneous viewing of multiple windows provides an operator access to information from multiple sources or applications. The following rules apply for use of multiple windows on a single screen display:

- Windows come up in a default-tiled fashion (no overlapping) whenever feasible. Sometimes, large or multiple windows preclude tiling.
- Windows within the work zone may be overlapped or cascaded only if the window being covered contains informational, non-critical data, and is not necessary to the operator actions being performed.
- Message, confirmation, and/or file retrieval dialog boxes may temporarily overlay the current window called the dialog box.
- Application and use of cascading or tiled windows is function/position dependent and is presented in Para. 6, Domain Specific Conventions

2.6 Feedback

(Ref: Para. 3.4.3.4 of ANSI/AIAA R-023-1995 HCISSO and Para. 3.6.3, 3.6.5, and 9.2 of User Interface Specifications for the DII, v. 3.0, 1998).

Specific to Satellite Operations functional requirements, the standard definitions for process status feedback and process outcome feedback apply. In general, the system provides feedback to the operator within acceptable response times and using acceptable refresh rates. For more information see Process Status Feedback and Process Outcome Feedback in the Developer's Style Guide. Feedback in the form of pop-up dialog boxes is categorized as confirmation pop-ups, warning pop-ups, or process status and process outcome pop-ups. The use of pop-ups is to be minimized to reduce unnecessary operator actions.

Confirmation pop-ups are used only in real time. They indicate: (1) that data will be lost during a Close or Exit operation, (2) termination of a process when another method was used to discontinue the process than a process status pop-up, (3) when an SSP is terminated unexpectedly, (4) an explicit destruction for which recovery is not possible, or (5) a critical action.

Warning pop-ups are only used when no other actions can be taken until the operator acknowledges the message. An audible notification (see p.11) accompanies all warning pop-ups. Note: A warning is an alert and most alerts are presented in the alert area (see Para. 3.1.3.2, Alert Area).

Process status and process outcome pop-ups don't require a response from the operator. Initial placement should minimize covering active windows. Operators can also move process status and process outcome pop-ups.

2.7 Recovery

(Ref: Para. 3.6.6 of User Interface Specifications for the DII, v. 3.0, 1998)

General undo capabilities are provided for reversing actions (i.e., drag transfers, clipboard transfer, deleting of data, etc.), unless a confirmation pop-up is used prior to action initiation. Actions that cannot be reversed are labeled appropriately and separated from actions that can be reversed. If a multiple level undo capability (i.e., reverses a series of previous actions) is provided, a Redo capability is also supported for reversing the most recently undone action.

3. Screen

The following sections describe conventions specific to screen layout and screen colors.

3.1 Screen Layout

(Ref: Para. 3.2.1.2 of ANSI/AIAA R-023-1995 HCISSO)

In accordance with the ANSI/AIAA HCISSO there are 5 zones: the header zone, the status zone, the toolbar, the work zone, and footer zone. Information typically contained in a footer zone is displayed in the status area or on individual windows in the work zone. Also none of the Commercial Off the Shelf (COTS) products or programs examined during this effort incorporated a footer zone in their design. For these reasons, the footer zone is not implemented in these conventions. Figure 3-1 presents an example of the overall screen layout. Some of the zone or component placements are optional. Refer to the paragraphs on each zone for details on required and optional layouts.

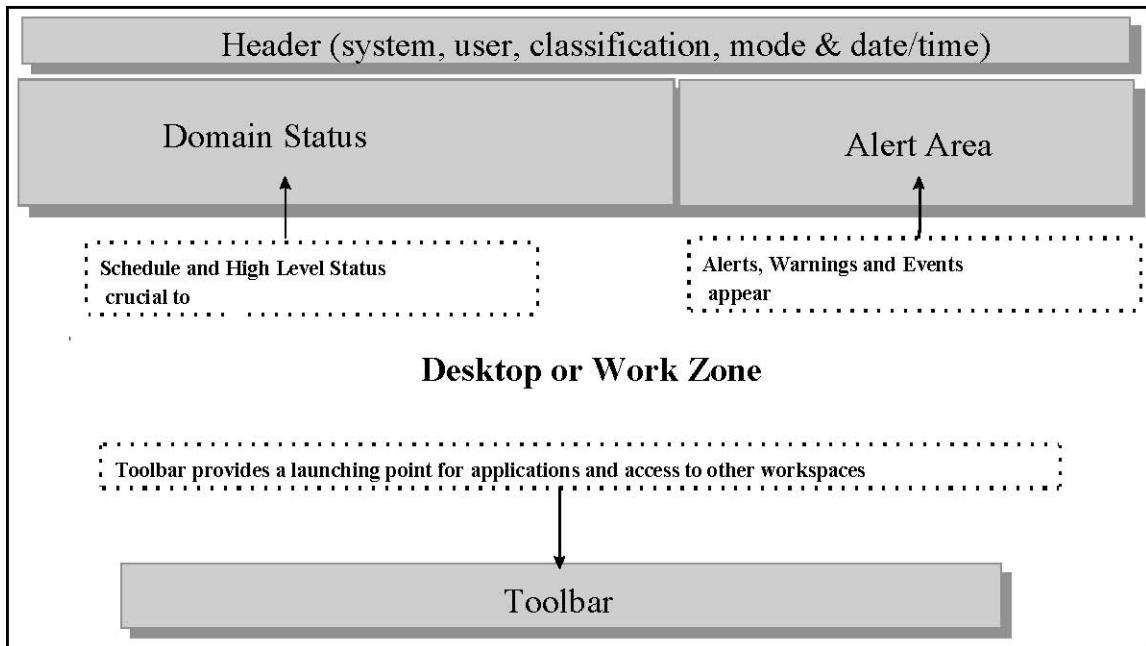


Figure 3.1. Screen Layout.

3.1.1 Zone Manipulation

Screens and windows can be reconfigured by designated crew or personnel to meet specific mission or operational requirements. Some windows/zones cannot be reconfigured due to the specific mission or operational requirements. Minimization/iconification and recommended configurations can be found in Para. 6, Domain Specific Conventions.

3.1.2 Header Zone

The following sections describe conventions specific to header zone characteristics and contents as well as dual display head considerations.

3.1.2.1 Characteristics and Content

The header zone is a reserved area, which appears at the top of the display screen. The header zone cannot be overwritten or covered. It contains: system identification information, user or position identification (optional), security classification, mode indicator, and date-time group. These items are displayed in the order listed with the classification centered on the screen (see Figure 3-2). Each item is displayed in an output field:

- System ID - Shows software type and version and Satellite system, SOC, or Mission Control Complex (MCC) ID
- User or Position ID - Shows who is currently logged into the system (optional)
- Classification - Shows the highest classification of the system (see Para. 3.2.3, Classification Colors in Screen Header)
- Mode Indicator - Shows the current mode of operations (i.e., Simulation, Test, Operational, etc.)
- Date/Time - Shows the current date/time group (format selectable, Zulu time is recommended as default)



Figure 3.2. Header and Status Zone Example.

3.1.2.2 Multiple Display Considerations

Three alternatives exist for displaying the header zone when multiple display heads (monitors) are being used.

- Alternative 1 - Display header zone only on one of the display heads.
- Alternative 2 - Display header zone in entirety on all display heads.
- Alternative 3 - Display header zone in entirety on one display head and display the classification field at the top center of the other display heads.

3.1.3 Status Zone

The status zone consists of two primary areas: the status area and the alert area. The status zone is displayed at the top of the screen, just below the screen header zone. The entire screen width (left to right) is used; however, the depth or number of lines may be tailored to specific functions or positions. See Para. 6, Domain Specific Conventions for display and configuration details.

- Status area (left _ to _ of screen width)
- Alert area (right _ to _ of screen width)

3.1.3.1 Status Area

The status area provides high level information on items or activities which are crucial to operations and must be constantly visible. The following specific types of information may be displayed. More detailed descriptions of status area content are presented in Paragraph 6, Domain Specific Conventions.

- Scheduled Activities - may include items such as upcoming satellite contacts or tasks to be performed
- Resource Status - may contain constellation, satellite, ground station, communication or system elements
- Process/Activity Status- may contain real time or offline process status
- Summary Status- may contain high level summary as in operational capability (OPSCAP) and situation status
- Domain specific status

3.1.3.2 Alert Area

This area presents notification messages to the operator for review and for action as required. Alerts are initially presented in the Alert Area (Alert Window). From the alert area an expanded view of all current alerts can be invoked. Once alerts have been acknowledged and removed from the alert area, they are retained in the Alert History file.

Notification messages are called alerts and include four specific types based on criticality: alarms, warnings, events, and informational messages. Alarms are the most severe and are color coded red (severe or critical problem or outage). Warnings are next in importance and are color coded yellow (degradation). Events and informational messages are colored white or green: green if a status is being reported, e.g., configuration change or an element is back on-line; white if a process has finished running. Other alert area attributes include: counters to assess number of alerts in the system and their distribution across categories, assignment of audible notifications as determined by criticality, the informational (text) message for each alert, and methods of acknowledging alerts. A program may choose to define whether or not the informational message category is required for their purposes. Specifics concerning the use and content of the Alert area and the detailed alert information are listed in the Para. 6, Domain Specific Conventions.

3.1.3.2.1 Alert Area Window

The following specific details about the Alert Area window apply across all domains:

- Minimum alert content of the Alert Area window includes: counters for message types, alerts requiring acknowledgment, an acknowledge button or capability, and a capability to access more detailed text on a specific alert.
- Alert messages contain information source, date-time group, and description; in that order (date may or may not be displayed).
- Alerts are color-coded based on criticality (see Table 3.2, Color Usage Definitions).
- All alerts can have an associated audible signal upon initial posting. Typically only alerts containing critical information (i.e., alarms) have an associated audible signal (See Para. 3.4.2.3, Audible Alarm Notifications, of the ANSI/AIAA R-023-1995 HCISSO).
- An operator has the capability to acknowledge an alert.
- Once an alert is acknowledged, it is automatically sent to an alert history. (Optional: It may be desirable for a program to allow the operator to manage when an alert is taken out of the active queue and stored in another location.)
- The alert area (window) provides access to more information on individual alerts.
- Counters for all message types (e.g., alarms, warnings, events, and informational messages) are shown in the Alert Area and the Expanded Alert window.
- Alerts are presented in an order set by the user (program or SOC). Some of the possible options for setting the order are based on criticality, time, source, or subsystem. Suggested default order is by criticality first and then by time, with the most recent alarm being presented first and the oldest informational message being presented last.
- Alerts may be grouped to separate alarms and warnings from other non-critical alerts (events and informational messages).

3.1.3.2.2 Expanded Alert and Alert History Windows

The following specific details apply to the Expanded Alert window or the Alert History window:

- The expanded window, when used, is placed immediately under the Alert Area window.
- The Expanded Alert window provides a view of all current alerts and is invoked from the Alert Area.
- The Alert History contains all past alerts that are not in the current Alert Area window and is invoked from either the Expanded Alert window or the screen Toolbar.
- Both the Expanded Alert window and the Alert History have multiple sort options, such as criticality, time, and source or subsystem.
- The Expanded Alert window provides access to the Alert History.

- Messages not requiring acknowledgment may be displayed only in the Expanded Alert window (in lieu of the alert area window, see program operational concept).

3.1.4 Toolbar

The screen toolbar, as displayed in Figure 3.3, is used as a launch point for applications and windows. Placement of the toolbar may be at the bottom of the screen to free up workspace and prevent confusion with the status zone. Other placements include immediately below the status zone and between the header and status zones. Placement below the status zone avoids covering items in the status zone. Placement between the header and status zones causes some items in the status zone to be temporarily covered, when menus in the toolbar are open. However, some systems require placement immediately under the header zone, above the status zone, to minimize changes to COTS products. The toolbar can contain menu items (e.g., File; Help, etc.) or specific function icons which launch applications (e.g., command generation; telemetry evaluation, etc.). The toolbar may allow for multiple workspaces to be identified for different satellites or resources (such as in Common Desktop Environment) thus allowing the operator to switch between different workspaces without closing those workspaces. Toolbar recommendations and specific contents are listed in Para. 6, Domain Specific Conventions.



Figure 3.3. Toolbar Example.

3.1.5 Work Zone

(Ref: Appendix E, Para. 3.2.1.2.F. of ANSI/AIAA R-023-1995 HCISSO)

The work zone is the area used to present window and application data. This zone is used to provide operator access to the functions in an application. The work zone does not overlap any of the other zones. It is sized appropriately to contain all the windows and application data needed for accomplishment of the mission.

3.1.5.1 Explicit Focus Model

(Ref: Para. 2.1.2 of OSF Motif Style Guide, v.1.2, Para. 3.1 and 7.2.3 of the User Interface Specifications for the DII, v. 3.0, 1998)

The explicit focus model is the recommended method for changing input focus between windows or components in a window, because accidental operator entries are not as prevalent as with the implicit focus model. Input focus indicates the window or component within a window that receives operator or keyboard inputs. In the explicit focus model, input focus is gained by clicking or selecting any portion of a window, which also raises the window to the front. Requiring operators to click or select only certain portions of a window (e.g., the window title bar) is not recommended.

3.1.5.2 Cursor Position

The default cursor position in a window is at the beginning of the first data entry field. A double click in a window, to apply input focus, positions the cursor at the nearest input field to the location clicked.

3.1.5.3 Multiple Displays

Several program specific operational concepts require the use of more than one display head (monitor) in their implementation to maximize the screen space. When multiple displays are used the windows and data should not be broken (separated) across displays, but fully contained within the work zone of one display.

3.2 Screen Colors

(Ref: Para. 3.2.1.4, ANSI/AIAA R-023-1995 HCISSO)

The colors presented in Table 3.1 are used in various combinations to identify button and field types and indicate status. Color is consistently applied within and across functional areas (domains).

Table 3.1. Color Definitions

| Color | Description of Use |
|-------------|---|
| Green | Used in on-line and off-line buttons, input and output fields, and on icons. Used on borders, top and left side (half) borders, and fill. Always indicates good, normal, or operational status. |
| Yellow | Used in on-line and off-line buttons, input and output fields, and on icons. Presented as borders or borders and fill. Always indicates a warning or degraded condition. |
| Red | Used in on-line and off-line buttons, input and output fields, and on icons. Presented as borders or borders and fill. Indicates alarm, critical status, or non-operational status. |
| Graying-Out | Indication for an inactive, unusable, or non-modifiable construct. Used in buttons, text fields, menu choices, and more. |
| White | (1) Indicates an unknown state when applied to a button. (2) Also used as fill in data entry (modifiable) fields. (3) Not used for status. |

3.2.1 Usage of Screen Colors

Status can be indicated using borders, fill, or combinations of borders and fill. Distinctions between on-line and off-line systems are made with fills and text. Avoid use of colored text (Ref: Para. 3.2.1.4.G, Alert Message Coloring, of the ANSI/AIAA R-0231995, HCISSO). Figure 3-4 is an example of a combination of borders, fill, and text used on buttons and in fields (input and output fields) to indicate status. Table 3.2 defines the example presented in Figure 3-4.

Standard Use of Color

| | | Unknown | Good | Degraded | Bad | Not Avail |
|----------------|-----|---------|------|----------|-----|-----------|
| Online | XYZ | XYZ | XYZ | XYZ | | N/A |
| | XYZ | XYZ | XYZ | XYZ | | XYZ |
| Offline | XYZ | XYZ | XYZ | XYZ | | XYZ |

OUTPUT FIELDS

| | Unknown | Good | Degraded | Bad |
|------------------|---------|---------|----------|---------|
| TextField | 12.3456 | 12.3456 | 12.3456 | 12.3456 |

INPUT FIELDS

| | No Entry | Valid | Invalid | Uneditable |
|------------------|----------|---------|---------|------------|
| TextField | | 12.3456 | 12.3456 | 12.3456 |

Figure 3.4. Example of Color Usage.

Table 3.2. Color Usage Definitions

| Buttons (appear raised) | Components | Unknown | Good | Degraded | Critical |
|-------------------------------------|--|------------------------|-------------------------|---|-----------------------|
| *On-Line System | Border: Fill: **Text: | White White Black | Green Gray Black | Yellow Yellow Black | Red Red Black |
| *Off-Line System | Border: Fill: **Text: | Gray Gray Dark Gray | Green Gray Dark Gray | Yellow Gray Dark Gray | Red Gray Dark Gray |
| | | | | | |
| Fields (appear sunken) | | Unknown | Good | Degraded | Critical |
| Output | Fill: Text: Inside Border/Shadow: | Gray Dark Gray None | Gray Black Green | Yellow Black None | Red Black None |
| | | | | | |
| | | No Entry | Valid Entry | Invalid Entry | |
| Input | ***Fill: Text: Inside Border/Shadow: | White None None | White Black None | White Black Red Indicated by a distinctive method *** Error Message | |
| | | | | | |
| | | | Good | Degraded | Critical |
| Icon | Fill: | | Green | Yellow | Red |
| | | | | | |
| | | Message | Event | Warning | Alarm |
| Alert Acknowledge Button | Fill: | None | White | Yellow | Red |

* Use of an icon within a button to indicate status can be used in place of border or fill. Use of the icon must not degrade and must enhance readability. ** There must be a reasonable distinction between gray and black text. Note: Gray text is darker and distinguishable from background color. Font size may also be used to help further distinguish between online and off-line systems. *** Use a different shade of gray from that used in Output Fields, this minimizes visual noise caused by large white input fields and still distinguish them from output fields. **** Error message (optional) and error check occurrence depends on the needs of the particular function/task, but only the listed options are available (e.g., Red border or pop-up window). An error check must occur and the criticality of the action drives the resulting level of error flag.

3.2.2. Background Color/Pattern

Use neutral colors (unsaturated hues, e.g., pastel colors or light gray) providing sufficient color difference to distinguish between screen desktop and windows displayed on screen. An exception to this is the case in which mission payload operations require the use of dark background colors to effectively display mission data as opposed to textual or numeric information (e.g., Defense Support Program (DSP) and SBIRS).

3.2.3 Classification Colors in Screen Header

(Ref: Appendix E. Para. 3.2.1.4.I. of ANSI/AIAA R-023-1995 HCSSO and Appendix E, Para. E.1, of the User Interface Specifications for the DII, v. 3.0, 1998)

The colors presented in Table 3.3 are used to indicate classification of screen data. Note that the methods of indicating classification are borders or fill. One or the other method may be used; however, a combination of the styles as listed below draws more attention to everything classified confidential or higher and is preferred when supported by the GUI tool.

Table 3.3. Classification Colors

| Classification | Color Name | Specific Color | Preferred Style |
|---|--------------|----------------|-----------------|
| Unclassified | Forest Green | 34, 139, 34 | Green Border |
| Confidential | Sky Blue | 135, 206, 235 | Blue Fill |
| Secret | Firebrick 2 | 238, 44, 44 | Red Fill |
| Top Secret | Dark Orange | 255, 140, 0 | Orange Fill |
| Special Compartmented Information | * Yellow | * | Yellow Fill |

* Color is not specially defined in User Interface Specifications for the DII, v. 3.0, 1998.

3.2.4 Other Users of Colors/Patterns

Use of color coding or patterns is allowed and recommended to identify between windows running the same activity or vehicle specific function. When used, pastel colors are displayed in the title bar. For example, color coding title bars of windows associated with particular space vehicles can facilitate operator recognition when windows from multiple contacts are open on the screen.

Avoid use of basic status colors such as green, yellow, and red for non-status items. Mission payload data (as in SBIRS) is an example of non-status data in which data discrimination is necessary and may require the use of the full color pallet, including green, yellow, and red. Patterns may also be used to further distinguish activities when colors are not sufficient.

3.2.5 Color Graphics

Lines which connect graphical elements, as in dynamic and interactive configuration diagrams, may be color-coded consistent with the status of the elements in the indicated path (e.g., good [green], degraded [yellow], non-operational [red], on-line [green or black], and off-line [grayed-out]).

4. Window

In general, minimize use of buttons to simplify screens when possible. The following sections describe conventions specific to window layout and window components. Note: Dialog boxes are windows for specific purposes and follow the same conventions used for windows.

4.1 Window Layout

(Ref: Para. 4.2.1.3 of ANSI/AIAA R-023-1995 HCISSO)

All windows have the basic window functionality controls (i.e., resize, maximize, minimize, and window menu button). In some domains a minimum size is set to ensure all data can be read legibly. Figure 4.1 presents an example window layout.

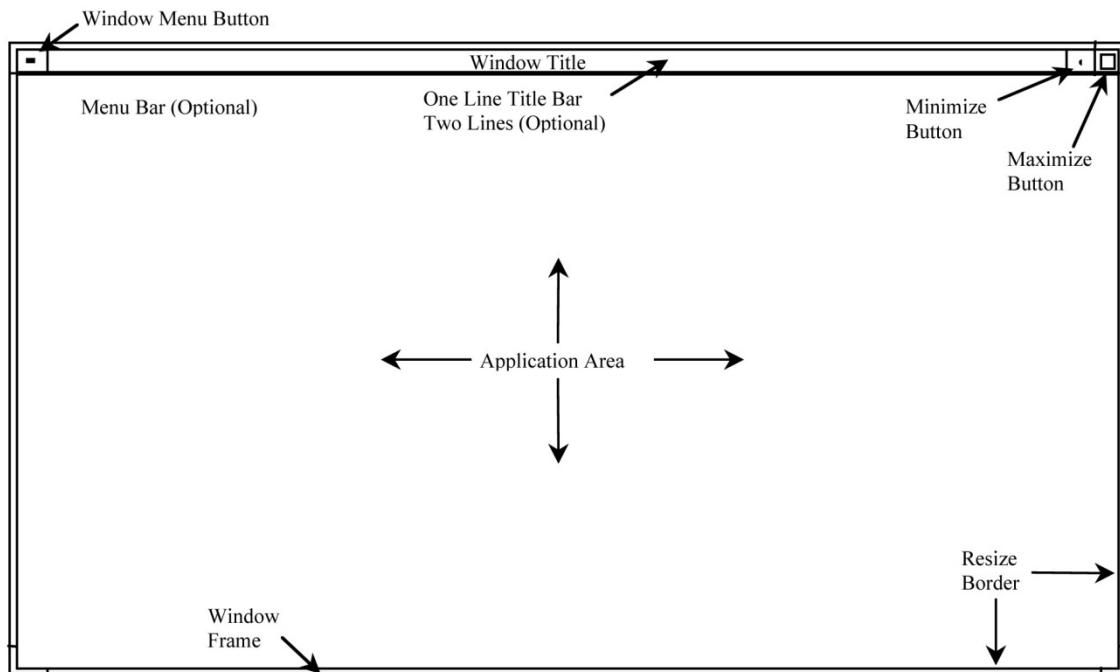


Figure 4.1. Window Layout.

4.2 Window Elements

The basic window consists of the following elements: window frame, sizing and placement controls, window title bars and window design components.

4.2.1 Window Controls

Window control buttons include the window menu button on the left side of the title bar and the minimize and maximize buttons on the right side of the title bar. These provide basic window functionality and are common to all windows except dialog boxes. Most dialog boxes include only the window menu button. The window menu provides access to window management functions, such as: restore, move, minimize, maximize, lower, and close.

4.2.2 Title Bar

The title bar is consistently displayed at the top of the window and may contain two lines. Figures 4.2 and 4.3 show examples of a one line and a two line title bar. The following alternative naming conventions are available:

Alternative 1 - Descriptive name centered in the title bar (name should match name of action that invoked window).

Alternative 2 - Title of parent window followed by a dash “-“ and the name of the subwindow beginning at the left side of the title bar.

Alternative 3 – Title of application or thread centered in first line and name of current window centered on the second line.

The title bar may contain the window's title, purpose, task performed, satellite vehicle controlled, remote ground facility, resource designator, and date-time. The information in the second line (if displayed) is function-dependent. However, display the information consistently across screen elements. Classification may also be displayed, if required, but it is typically only indicated in the screen header zone. When used, classification appears centered in the top most portion of the window. Display fields are contained within the window display status in accordance with the color matrix in Table 3.2, Color Usage Definitions. When the satellite identifier, resource designator, and/or time are appropriate to display, they are located as described below:

- Satellite Identifier - always left side of title bar
- Resource – left side of title bar and if applicable on right side of satellite identifier
- Time - function/position dependent format, right side of title bar

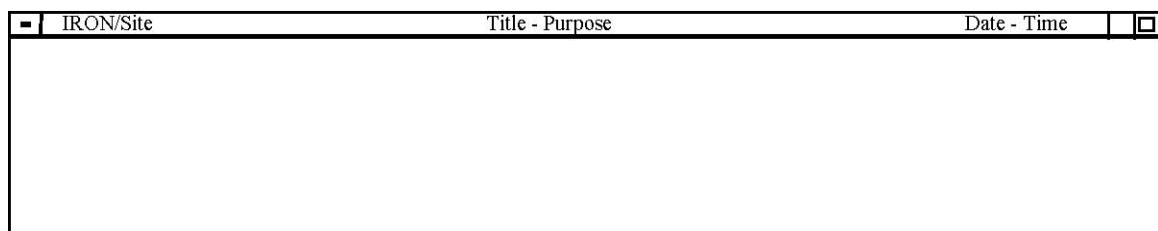


Figure 4.2. One Line Title Bar Example.

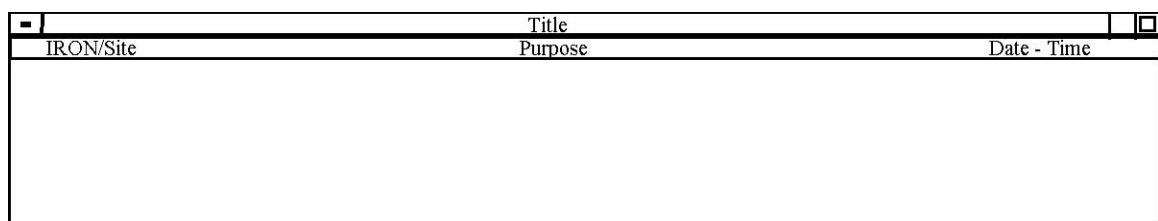


Figure 4.3. Two Line Title Bar Example.

4.2.3 Window Design Components

The following paragraphs reference source information and list a summary of attributes for each component. Refer to referenced data or the Developer's Style Guide for more details.

4.2.3.1 Menu Design

(Ref: Para. 3.1.3.1 of ANSI/AIAA R-023-1995 HCISSO and Para. 5.0 and 8.1.2 of User Interface Specification for the DII, v. 3.0, 1998)

Paragraphs in this section describe conventions specific to menu design such as: menu bar, pull-down menus, submenus, pop-up menus, tear-off menus, option menus, and design considerations.

4.2.3.1.1 Menu Bar Conventions

Specifics on what is contained in a menu bar can be found in Para. 6, Domain Specific Conventions. The following are menu bar characteristics:

- Located immediately below the title bar
- Contain cascade buttons arranged side-by-side horizontally
- The cascade buttons have a textual label and no graphic
- The text label in each cascade button is a menu title
- A menu bar contains no more than 10 menu titles (cascade buttons)
- When not selected the cascade buttons have no visible border. The horizontal group of cascade buttons appears as a list
- When selected the cascade button border is visible and the button appears raised

The menu bar contains the following menu options and actions:

- a) File (if applicable) - far left of menu bar
- b) Help (if applicable) - far right of menu bar
- c) Other menus/actions as required

4.2.3.1.2 Pull-Down Menu Conventions

- Provide quick and consistent access to actions, submenus, and settings for parameters.
- Consists of a cascade button, which is also the menu title, that when activated displays a set of options either below, beside, or above the button.

- The options can be actions, routings to a window or submenu, or settings that define parameters.
- Contains no less than 2 and no more than 15 options (Para. 5.5.3, Grouping into Menus and Submenus, of the DII, v. 3.0, 1998).
- After a selection is made the menu is closed.

4.2.3.1.3 Submenu Conventions

- A child of a pull-down or tear-off menu is invoked by selecting an option in a menu.
- Submenus are limited to two levels below the parent menu option.
- Submenus contain at least three options; otherwise, the options are placed in the parent menu.
- After a selection is made, the menu is closed.

4.2.3.1.4 Pop-Up Menu Conventions

- Provide the experienced user with a quick way to perform common tasks on individual elements.
- Is hidden from the user and is posted (activated) by clicking the right mouse button or other action.
- Options can be accessed elsewhere in the application.
- After a selection is made the menu is closed.
- In Motif, the menu includes a title separated from the first menu option by a separator line
- In windows, a title is not needed.

4.2.3.1.5 Tear-Off Menus Conventions

- Used when selections are made repeatedly from a pull-down menu, submenu, or popup menu.
- Appear as other menus (pull-down, submenu, or pop-up).
- Has a tear-off button either before the list of options or after the title.
- Tear-off button contains a dashed line graphic that indicates the tear-off action.
- After a selection is made the menu remains open.

4.2.3.1.6 Option Menus Conventions

- Used to select from a discrete set of values or choices that are not likely to change.

- When used, the currently selected option replaces the text field in the button.
- When used, the Option menu label is placed either above or to the left of the button.
- Selection of the arrow graphic, which is placed on the right side of the text field, activates the menu.
- Upon activation, the options are displayed in a list box or scrollable list box.
- Selections are made by depressing and holding the right mouse button until the desired option is highlighted and then releasing the mouse button.
- Not used for critical choices, because unintentional selections can be made.
- Used when the number of choices (options) does not exceed 12.

4.2.3.1.7 Menu Design Guidance for All Menus

- One option is displayed per line and the first letter of each word is capitalized.
- All menu titles and menu options have mnemonics. For example: Save
- Frequently used menu options have accelerator keys. For example: <Ctrl> S
- Separators are used to delineate groups of options.
- Menu or option selection is identified by highlighting.

4.2.3.2 Label Conventions

- A label is a text descriptor for a button, input field, output field, option menu, or section of window.
- Label background color is the same as window background color.
- Default text color is black.
- Text labels are aligned on the left most character.
- Numeric labels are aligned on the decimal point.

4.2.3.3 Input Field Conventions

(Ref. Para. 6.8 of the User Interface Specification for the DII, v. 3.0, 1998)

- Appears sunken.
- Input (editable) fields contain white or cream colored fill.

- Multiple line input fields contain a darker gray fill than output fields and the window background. This reduces visual noise caused by large white fields and still distinguishes input fields from output fields.
- Status can be indicated through use of borders, see Table 3.2, Color Usage Definitions.
- The default cursor position is on the left most character or number. However, entry at any point in the field is allowed.
- Text is left justified.
- Numeric fields are right justified and columns are aligned on the decimal point.

4.2.3.3.1 Combo Box Conventions

(Ref. Para. 6.11 of the User Interface Specification for the DII, v. 3.0, 1998)

- Used to either enter a value or option or to select from a list of values or options in a list.
- Allows text entry in the text field and/or selection of an option (item) from the list box or scrollable list box.
- Contains a left justified text field and an arrow button (small push button) on the right side that activates a list box. See Option Menu for more detail on the list box, activation, and option selection.

4.2.3.3.2 Linked Input Field Conventions

- Used when values of a parameter are frequently displayed in different units.
- Consists of two input fields that are linked by a mathematical relationship or some other relationship.
- After a value is entered or edited in one of the fields, a corresponding value is displayed in the other field.

4.2.3.3.3 Display Input Field Conventions

- Used for verification purposes.
- Consists of two fields: an input field and an output field.
- The output field is placed directly under the input field.
- Entries are made in the input field.
- After entries have been made they are displayed in the output field.

4.2.3.4 Output Field Conventions

- Appears Sunken.
- Output fields are distinguished with gray fill (the same color as the window background).
- Status indications through use of borders, fill, and combinations of both, see Table 3.2, Color Usage Definitions.
- Textual output fields are left justified and columns of textual output fields are aligned on the first character.
- Numeric output fields are right justified and columns of numeric output fields are aligned on the decimal point.
- If more than a single line of data needs to be displayed, scroll bars (vertical) are added to facilitate scrolling of the viewable area. Note: Avoid use of horizontal scroll bars, only added as a last resort.

4.2.3.4.1 Scrollable Table

- Appears as a multiple line output field with multiple columns.
- May indicate separation between columns as part of the background design. The table has a vertical scrollbar on the right side of the furthest right column for moving the viewable area.

4.2.3.5 Button Conventions

(Ref: Para. 3.1.3.4 of ANSI/AIAA R-023-1995 HCISSO and Para. 6.1 of the User Interface Specification for the DII, v.3.0, 1998)

Buttons should be used for frequently executed actions or for the convenience of the operator. The following paragraphs contain specific implementation conventions.

4.2.3.5.1 Appearance

- Rectangular construct (wider than high or square).
- Appears raised (light colored border [edge] on top and left side, dark gray shadow on bottom and right side).
- Contains a label or graphic centered in the button.
- Groups of similar buttons are the same size. Exceptions are possible when label sizes vary widely.
- Columns of buttons are aligned on the left side. Rows of buttons are aligned on bottom.
- Black text is used for on-line systems.

- Grayed-out text is used for off-line systems.
- Status can be indicated through use of borders, fill, or combinations of both as well as the use of icons, see Table 3.2, Color Usage Definitions.

4.2.3.5.2 Behavior

- Activated by a left mouse click or keyboard enter/return action.
- When selected, has visual indication of activation.
- Secondary or alternative access to button functionality can be provided through a menu bar.

4.2.3.5.3 Push Button Conventions

- Contains textual, graphic, or icon label centered in button.
- Activates frequently executed actions, commands, or routings (opening another window).

4.2.3.5.4 Status Buttons

- Indicate status of a component or sub-system through appropriate color coding (see Tables 3.1, Color Definitions, and 3.2, Color Usage Definitions) or use of status icon.
- Provide hierarchical access to additional lower level information when selected.

4.2.3.5.5 Common Action Buttons

(Ref: Para. 6.2.4.1 of OSF Motif Style Guide, v.1.2 and Appendix C of the User Interface Specifications for the DII, v.3.0, 1998)

Table 4.1. Common Button Actions

| Button Label | Action Definition |
|--------------|---|
| Add | An ‘Add’ push button is used to add a selected item from a list in an instance where multiple selections are possible. |
| Apply | Executes the action or current changes, but leaves the window open (see OK). |
| Back | Recalls the window that invoked the current window and moves the input-focus to that window (i.e., navigate back to the previous window). |
| Cancel | Closes the dialog or current window without implementing, saving, or executing any changes or selected actions. Does not close any associated windows. Do not use Cancel to close windows in which action has been initiated and cannot be terminated. Cancel is often used on transitory dialog boxes. |
| Clear | Removes data from the selected portion of an input field and does not compress the remaining space occupied by the cleared data. |
| Clear All | Removes data from all input fields and does not compress the remaining space. |
| Close | Closes current window without performing any of the actions specified by the components in the window. If items in the window have been modified since the last save action, a dialog confirming the Close action is displayed (see Exit). |
| Delete | Removes the selected data and compresses the associated spaces. |
| Edit | Provides a pop-up menu or edit control window with edit options such as cut, copy, move, paste, and delete. |
| Exit | Closes all windows in an application and ends processing by the application. Is located in main application window (use close for secondary windows). Unsaved changes will be lost, a dialog confirming the Exit action is displayed. |
| Expand | Invokes another window, which contains more detail. |
| Forward | Invokes the next window in a sequence of windows used to accomplish a task and changes input-focus to the new (next) window (i.e., navigate from current window to next window in task sequence). |
| Help | Activates the help feature when additional information is available (See Para. 5, Help). |
| No | Performs action of answering “No” and closing dialog box when used with a dialog box. Used in combination with “Yes”. |
| OK | Applies any changes, performs related actions, and closes the window/dialog box (see Apply). |
| Pause | Causes the task in progress to be paused. Used in combination with a Resume button. |
| Reset | Removes any changes or actions that have not been applied. Window/dialog box reverts to display of previous state with the initial values or the values the last time changes were applied. Does not close the window/dialog box. |

| Button Label | Action Definition |
|--------------|--|
| Resume | Causes previously paused task to resume. Used in combination with a Pause button. |
| Retry | Causes the task in progress to be paused and re-executed. This action is commonly found in message dialog boxes that report an error. |
| Save | Writes changes to a data file or storage device, but leaves the window open. If previously saved information will be overwritten, a confirmation dialog box is necessary. If alternative locations for saving the data are available, a dialog box that enables the user to select the location and/or filename will be presented. |
| Submit | Sends current states, conditions, or commands to an external device for further processing. |
| Yes | Performs action of answering “Yes” and closing dialog box when used with a dialog box. Used in combination with “No”. |

4.2.3.5.6 Button Order

(Ref: Para. 9.0 Dialog Box of OSF Motif Style Guide, v.1.2)

When more than one common button is used they are typically arranged horizontally across a window in a button box (see Para. 4.2.2.5.7, Location of Buttons) and are presented in the following order from left to right (See Para. 4.2.3.5.5, Common Button Actions, for usage considerations).

- OK - Close - Apply - Retry - Pause - Resume - Reset - Cancel - Help
- Yes - No - Apply - Retry - Pause - Resume - Reset - Cancel - Help

4.2.3.5.7 Location of Buttons

The following are recommended:

- Utilize button boxes. Button boxes are horizontal groupings of buttons. Buttons are placed side-by-side across a window, normally in one, but occasionally in two rows. Buttons in a button box are placed so that they appear together, but no frames or border are used to separate the button box from the rest of the window.
- Buttons that act on the entire window are located at the bottom of the window in a button box.
- Buttons that act on a portion of a window are located in a button box within a frame that includes the fields that are acted upon.
- Button boxes placed horizontally at the bottom of a window or within a frame are spaced symmetrically across the width of the window.

4.2.3.5.8 Cascade Button Conventions

- Used to initiate selection of an option from a menu list box.
- Contains a textual label centered in button.
- Contains an arrow graphic that points the direction the menu list box is to be posted.

- When activated (depressed, selected), it opens a pull-down menu.

4.2.3.5.9 Option Button Conventions

(Ref: Para. 6.1.1 and 6.14 of the User Interface Specification for the DII, v.3.0, 1998)

- Use to activate an Option menu to select from a discrete set of values or choices.
- Contains text label and either an arrow or horizontal bar graphic on left side in the button.
- The currently selected option replaces the text label in the button.
- Invokes an Option menu (see Para. 4.2.3.1.6, Option Menu Conventions).

4.2.3.5.10 Toggle Button Conventions

(Ref: Para. 6.2 and 6.3 of the User Interface Specification for the DII, v.3.0, 1998)

- Used to select options in an application by choosing between two states: On and Off, Enabled or Disabled, etc.
- Check buttons are a set of toggles used for selecting (setting) any number of options.
- Radio buttons are a set of toggles used for selecting (setting) only one option from a number of options.
- Toggle buttons have a label either on the left or right side of a small push button. Toggle buttons normally have circle shaped push button, check boxes have a square push button, and radio buttons have either a diamond or circle shaped push button.
- When selected, the push button is filled with a dark color, such as a dark gray or black. An optional implementation used with check boxes is for selected options to be filled with a black check mark.
- When not selected, the graphic fill in the push buttons is the same color as the window background.

4.2.3.5.11 Spin Button Conventions

(Ref: Para. 6.13 of the User Interface Specification for the DII, v.3.0, 1998)

- Used to select from a discrete set of ordered values.
- Single line of text with up-and-down-pointing arrows (small push buttons) on the right side of the text field.
- Selecting one of the arrow buttons changes the value displayed in the text field to the next discrete value of the ordered set.
- Values can be entered directly into the text field. This allows the set of values to be used for checking the validity of the entered value.

4.2.3.6 Slider Bar Conventions

(Ref: Para. 6.15 of the User Interface Specification for the DII, v.3.0, 1998)

- Use to select a value from a discrete set of ordered values.
- Contains either a horizontal slider or a vertical slider and an output field the same length (or height) above (or to the left of) the slider.
- The position of the slider has an associated value that is displayed in the output field immediately above (or to the left of) the slider current position.

4.2.3.7 Moving Selected Material Between Lists

Multiple methods are available from moving selected material from one list to another.

- Drag and drop.
- Pick-and-put buttons - buttons with labels Add, Add All, Remove, and Remove All.
- Pick-and-put directional arrows – buttons with directional arrows. Another optional implementation uses positional pick-and-put buttons for repositioning items in the destination list.

4.2.3.7.1 Drag and Drop

This is a method of moving data on a display or between displays. A user ‘clicks’ on an item and while continuing to depress the left mouse button, the item is ‘dragged,’ moving the mouse, to a new location on the same display or another display. The user then ‘drops,’ releases the mouse button, to complete the item movement.

4.2.3.7.2 Pick-and-Put Button Conventions

(Ref: Para. 9.1.5 of the User Interface Specification for the DII, v.3.0, 1998)

- At least two list boxes are placed either side-by-side or one on top of the other.
- One of the list boxes is designated as the destination and the other list box(es) are the source.

- Items selected in the destination list box and moved to a source are removed from the destination.
- Movement of selected material is accomplished with either pick-and-put buttons or pick-and-put directional arrows.
- Items selected in a source list box and moved to the destination remain available in the source. An optional implementation would also remove moved items from the source list box(es).

4.2.3.8 Tabbed Pages

(Ref: Para. 6.7 of the User Interface Specifications for the DII, v. 3.0, 1998)

- Use to decrease navigation movements when changing between related or similar windows.
- Use as a tab button to select different windows or portions of windows.
- Tab button when selected has no bottom border. It appears to be connected to a portion of the currently displayed window.
- Each tab button has an associated portion of window, that when selected overlays the portions of windows associated with the other tab buttons.
- A set of tabbed pages appear similar to a set of file folders in a drawer with tab labels.
- Normally tab buttons are placed beside other tab buttons (in a horizontal line).
- Each tab button has an associated partial window.
- When a tab button is selected the associated partial window replaces that current portion of the window.

4.2.3.9 Scroll Bars

(Ref: Para. 6.4 of the User Interface Specification for the DII, v.3.0, 1998)

- Controls for moving the viewable area of a component in the vertical and/or horizontal direction.
- Are added to multiple line input fields, output fields, menu list boxes, etc., when the component size exceeds the viewable area.
- Consists of a slider moving within a trough region that indicates the full size of the component.
- Movement of the slider is accomplished with arrow graphics on either end of the trough region and by moving the slider with the mouse.
- For vertical movement, the scroll bar should be located on the right side of the scrollable material.

- For horizontal movement, if needed, the scroll bar should be on the bottom of the scrollable material.
- The position of the slider represents the position of the viewable information relative to the size of the component.

4.2.3.10 Gauges and Dials

(Ref: Para. 6.15.1 and 12.2 of the User Interface Specification for the DII, v.3, 1998)

- Use to indicate processing or parameter status. Particularly useful when the direction of change in a value is more important than the exact value.
- Gauges contain a trough region that fills dynamically to indicate the amount of processing.
- Dials contain a pointer used to indicate the current value.
- Gauges and dials can be circular, horizontal, or vertical.
- Has an optional label with black text showing the current value or the amount of fill.
- Out-of-limits (warning and critical) range markings are usually color coded. Out-of-limits areas of filled color coding should only be visible when the system is in an out-of-limits state.

4.2.3.11 Sorting Lists

- Sorted lists can be in ascending or descending order.
- Multiple fields and/or parameters can be sorted simultaneously. A hierarchy of priority is selected when multiple fields or parameters are used.
- Columns can be sorted by selecting the column heading.
- Option menus or check buttons can also be used to select the fields or parameters for sorting.

4.2.3.12 Use of Icons/Symbology

4.2.3.12.1 Definition

(Ref: Para. 3.2.1.6.5 of ANSI/AIAA R-023-1995 HCISSO).

An icon is a low fidelity pictorial symbol on the display window that can be used to activate an action, set of actions (e.g., a process), or to represent a collapsed application task window. An icon usually occupies less than one square inch in area. Icons can be used to represent a window in a collapsed state to save room or to unclutter the workspace. Window contents are not visible in an icon. Application window icons are provided by the application when the operator clicks on a designated spot on the open window. Each type of window that can be iconified has a unique icon to distinguish it from other types of windows. Icons usually have a label at the bottom of the icon.

4.2.3.12.2 Window Icons

When a window is made into an icon, a descriptive (meaningful) label that identifies the window is attached. Unless specified in Para. 6, Domain Specific Conventions, all windows can be made into icons. Note that some domain specific operations (i.e., critical and real time operations) preclude making windows into icons. However, the header zone, status zone, and toolbar cannot be made into an icon.

4.2.3.12.3 Hierarchical Icons

- Used to access more information (typically invokes another window) on the subsystem or component described by the icon.
- Appears as a graphic with a label centered under the icon.
- Can indicate status using color coding, see Table 3.2, Color Usage Definitions.

4.2.3.12.4. Status Icon

- An icon used to indicate status.
- Cannot be selected to invoke any actions.
- Typically placed beside, and associated with, an output field or button.

4.2.3.13. Graphical Diagrams

- Schematics, block diagrams, flow charts, and wiring diagrams can be displayed as a portion of a window or as the entire window.
- Static diagrams are displays that do not contain any status information or the ability to access more information on particular components.
- Dynamic diagrams are displays that do provide real time status information on some or all of the components in the display.
- Interactive diagrams are displays that provide real time status information and the ability to access more detailed information on particular components.

5. Help

(Ref: Para. 3.4. of ANSI/AIAA R-023-1995 HCISSO and Para. 11.0 of User Interface Specifications for the DII, v.2.0)

Note: The degree to which a program employs the Help conventions must be weighed between the system concept of operations and the funding. Some of the conventions are not part of existing COTS applications and require development and integration into the system.

The Help conventions provide access to multilevel on-line guidance using prompts, advisory messages, and so forth. Help may include system information (e.g., navigation help) and/or task-oriented information (e.g., step and process help). Help is not meant to tutor operators but instead is meant to assist them in recalling information to perform the specific task at hand. Help provides procedural aids, provides the ability to recover from errors, and provides advice without requiring the user to exit the application.

Context-sensitive on-line documentation help, when used, provides information that considers the current environment, interrelated conditions, occurrences of events, and other factors that exist which affect the current operation. Context-sensitive help, when used, describes the purpose of the item or procedure, and the expected operator interaction with the item or procedure.

5.1 Methods of Receiving Help

- <F1> function key or the <Help> button.
- Shift <F1> or Shift <Help> provides context-sensitive help.
- The pop-up menu from a right mouse button click.
- Help push button.
- If a menu bar is used, place Help on the right end.
- Positioning the cursor over items on the menu bar, push buttons, or acronyms for item description.

5.2 Placement of Help

- Position a Help window or bubble (pop-up area with a lighter color background than the window background) so as not to obscure the object(s) it is describing.
- Initial placement covers the least amount of information in the active application.
- Place a Help window or bubble (in descending order of preference) to the right, left, above, or below the content for which help was requested.
- Help windows are moveable, resizeable, and modeless (allowing interaction with the secondary window and all other windows).

5.3 Contents of Window Specific Help

- Is accessible from a window.
- Contains a purpose statement that describes the task(s) that the users perform in the window.
- Describes tasks as they relate to the functionality provided by the application and from an operational perspective.
- Text is presented in mixed case, with capitalization, bold, or highlight to emphasize significant information.
- Presented items can be in bulleted form.
- Items can be sequentially numbered steps.
- Use graphics to supplement the text where appropriate.
- Examples may be used to explain complex ideas.
- Present step-by-step explanation of how users execute the task(s) for which Help was requested.

5.4 System or Application-Level Help

- Is accessible from the primary (parent) application window, normally from the Help menu.
- Provides on-line technical support documentation such as: electronic Orbital Operations Handbook (OOH), vehicle schematics, photos, definitions of options, system capabilities, procedures, abbreviations, acronyms and ranges of values that should be displayed. Note: Much of this on-line documentation is also accessible from window specific help.
- Provides overview of tasks performed in application.
- Provides access to more detail on particular tasks and steps.
- Wizards are a common method for providing detailed task description information, including step-by-step instructions.

5.5 Context Sensitive Help

- When invoked (Shift <F1> or help menu selection), changes the pointer to a “help” shape. User moves pointer to a component (object) and left clicks mouse to display information about that component.
- Describes the nature of and how to use a particular control (check button, radio button, slider bar, data entry field, etc.), component, or current transaction.

5.6 Help Menu Options

- Context Sensitive Help - Alternative way to invoke context sensitive help.
- Index-of all topics with categories such as; functions, commands, keys, etc. All indexes should be alphabetical and provide quick search capabilities. Note: Index categories can also be separate items in Help menu.
- On Help - Provides information on how to use application help facility.
- On Window - Specific to current window.
- Tutorial (optional).
- Version - Provide name and version of application.

5.7 Acronyms and Data Items

- When the cursor is placed over an acronym, the expanded label (text) describing the acronym is displayed in a pop-up area (bubble).
- Clicking on a data item to highlight the item displays the definition or information about the selected item.

6. Domain Specific Conventions

6.1 Satellite Contact Operations Conventions

6.1.1 Description

Contact Operations consist of satellite support activities to include: execution of individual satellite contacts, configuration/deconfiguration of resources, execution of the satellite support plans, in-procedure anomaly resolution, status reporting, and coordination with external agencies as required.

One of the products reviewed for this domain was the LORAL System 90, used in 5 SOPS as a Mission Unique Equipment (MUE) telemetry processor. The specific items reviewed on this system were the telemetry windows, graphics, window navigation, and screen layout. The GPS processing system telemetry windows were also reviewed. Some of these windows were recreated in the UIM/X tool to exhibit how these windows match or can be altered to meet conventions. The following is a list of the windows that were recreated:

- Attitude
- Propulsion
- Satellite Processing Unit

6.1.2 Screen Layout

Described below is screen layout information regarding arrangement of windows and navigation, rules on overlapping windows, as well as definitions and handling criteria for critical information.

6.1.2.1 Arrangement of Windows and Navigation

Accelerator and functions keys are available for frequently used functions. Examples of functions requiring shortcut keys are in Table 6.1, Contact Operations Default Shortcut Key Definitions.

Table 6.1. Contact Operations Default Shortcut Key Definitions

| Shortcut Key | Function / Action |
|--------------|----------------------|
| F2 | Network Status |
| F3 | SOC Equipment Status |
| F4 | Contact Status |
| F5 | Configure Front End |
| F6 | Configure KGs |

The SCREENS option on a window menu is a specific implementation of a list of windows that the user can activate quickly. Function keys, accelerator keys, and push buttons are other methods that allow director access to windows and functions. Direct access to windows and functions is useful to Contact Operations and allows the operator to quickly obtain Contact Operations functions, to switch automation levels, and to monitor all facets of the contact.

6.1.2.2 Rules on Overlapping Windows

Non-overlapping or tiled convention for window placement is recommended in the Contact Operations domain for the following reasons:

- Contact Operations is a real-time domain that frequently requires more than one window to be opened for simultaneous viewing.
- Timeliness of operator actions requires that operator window manipulation or placement be reduced or eliminated.
- Operator screen management and extra steps are typical of overlapping or cascaded windows.

This design convention does allow for dialog and feedback windows to appear on top of (or overlapping) the current window when an operator action is required prior to leaving the window or continuing to the next step.

6.1.2.3 Definition and Handling of Critical Information

The critical data in the Contact Operations domain can include anything that prevents the mission from being accomplished, or which poses a danger to personnel. Some examples are: satellite anomalies, ground anomalies, communication outages, degradations or failures of almost anything related to contact operations mission, fire alarms, emergency messages, and so forth. As described in Para. 3.1.3.2, Alert Area, critical alert information is color-coded, accompanied by an audible notification, appears in a dialog window, or appears in the alert area as a message. Operator notification of critical alert data requires operator action/acknowledgment such as a click on a button via a dialog window or an alarm acknowledgment.

There are multiple functions that can be employed in identifying critical data in a Contact Operations window. Commands, directives and functions can utilize the color-coding convention on the text field that displays the results of these actions. Limits can be placed on parameters that have a range of acceptable values. The color conventions of yellow for warning state and red for alarmed state are used to identify the values that are not in the acceptable range of values. To allow for high-level data monitoring, a hierarchical status notification can be employed. A high level window uses the color convention on a button to convey that a subsystem or a portion of the subsystem is reporting degraded or critical telemetry data. The user can click on the button to obtain more detailed information on the subsystem and locate the degraded or critical telemetry data.

6.1.3 Header Zone

The header zone for Contact Operations utilizes the conventions as described in Para 3.1.2, Header Zone. The items that are most pertinent to this domain are the security classification and user identification, for obvious security reasons, and mode indicator, for operator situational awareness.

6.1.4 Status Zone

The status zone contains the status area and the alert area. Both areas display data that is essential for the operator to keep in view at all times. For Contact Operations, this kind of data may include: a current schedule of supports, single contact status, multiple contact status, system status, external

equipment status, remote station status, and network status. The section below describes Contact Operations specific status area and alert area conventions.

6.1.4.1 Status Area

The following components are examples of the content that may be displayed in this area.

6.1.4.1.1 Activities Schedule

Alternative 1- The Activities Schedule includes a view of current and upcoming contacts on the schedule. The operator can start a contact by double-clicking on the contact line in the schedule. The schedule can be sorted by the column titles. The sorting feature is accomplished by placing the column title on a button. Activation of the button sorts the schedule by the selected column title in ascending order. An additional behavior of the button is a toggle feature, which allows the sort to switch between ascending and descending order.

Alternative 2 – A view of the scheduled contact events is in a timeline format. The timeline displays times on one axis and the total number of possible contacts on the opposing axis. The length of the box representing the contact depicts contact duration. The vehicle Interange Operations Number (IRON) labels the box. The user could define colors to further define contact attributes such as minimum manning level or type of contact (state of health, tracking, or maneuver).

6.1.4.1.2 Resource/Activities Status

Resource/Activities Status includes a view of contact resources for the operations complex.

Alternatives include:

Alternative 1 - Shows all active contacts (up to 6) for the complex. The active contacts are listed by satellite identifier and the graphical status display changes per selected satellite.

Alternative 2 - Shows the status of one current contact. A graphical representation of the contact resources displays the status of the contact.

6.1.4.2 Alert and Message Area

The alert and message area follows conventions described in Para. 3.1.3.2, Alert Area. Table 6.2 provides examples of Alarms (A), Warnings (W), and Events (E). Note that the source can be an IRON number, ground element, or external location.

Table 6.2. Contact Operations Alarms, Warnings, and Event Examples

| Criticality | Date/Time | Source | Text |
|-------------|--------------|--------|-------------------------------|
| A | 149/00:23:00 | 1234 | Loss of data |
| A | 149/00:20:00 | 1234 | Loss of Sync |
| W | 149/00:19:00 | 1234 | APA buffer below limit |
| W | 149/00:17:00 | 1234 | Inconsistent time from source |
| E | 149/00:14:00 | 1234 | Data acquired |
| E | 149/00:13:00 | 1234 | Antenna is radiating |

6.1.5 Toolbar

The operations associated with Contact Operations are typically time critical operations. The toolbar can be placed either above or below the status zone or at the bottom of the screen. Care must be taken to choose a location that avoids a situation in which critical data is covered by the toolbar menus when open. The toolbar pull down menu selection would appear highlighted if the pull down were accessed again. The following provides the recommended content of the toolbar:

- SOC Control Monitor - Internal resource configuration, system control, initiate and terminate contacts, logoff
- Commanding - Commanding windows, contact plan (loading, viewing)
- Telemetry - Telemetry launch points, telemetry limit control point
- Pre-Pass - Pre-Pass tests, brief, and ARTS monitoring
- Playback - Telemetry playback, initiation
- Print - Prints of window or specific screens
- Utilities - Terminal access, calculator
- Help - System, vehicle and pass plan help

6.1.6 Contact Operation Specific Conventions

Listed below are Contact Operation specific conventions:

- Color status indicators are used in resource status windows to provide a general view of equipment pieces.
- Only configurations defined in a vehicle database can be selected.
- Contact progress is conveyed by moving data between upcoming and history lists. Status of the item is also displayed in the list.

- System generated default input is based on previous user input. The user may still edit the selection but the system utilizes the previous user input to minimize user inputs where applicable.
- The list filter option allows a list to be sorted by specifying the main criteria of the sort which is selected with toggle buttons.
- The sort list input allows for the user to type the sorting criteria in an input field. Once the criterion is completed, the system performs the sort upon a button selection.
- Dials, meters, and gauges are different ways to display data. These graphics are used to emulate mechanical devices.
- The following are buttons with specific titles and functions used only in the Contact Operations domain:
 - Monitor – Allows a user to view the contact data. Control of the contact is not available from this function.
 - Take Control – Allows a user to obtain control of a current contact. The previous user releases control to the new user, which is the user selecting the ‘Take Control’ button.
 - Begin Contact – Allows a user to begin a contact that does not have an SSP, pass plan, and has been configured manually.
 - Next Rev – Allows the user to use the next tracking station visibility in the upcoming revolution of the predicted vehicle orbit data. The input fields are populated with the data from the predicted vehicle orbit data.
 - Test and configuration buttons perform pre-pass tests and equipment configurations for vehicle contacts.
 - Send – Transmits commands and directives from the ground systems through the antenna and to the vehicle.
 - Abort – Discontinues the execution of the current transmission to the vehicle and/or execution of the pass plan.
 - Apply Offset – Executes a directive to sync the antenna pointing angles to a certain time offset. The Antenna Off set input field accepts the time offset from the user.

6.1.7 **Contact Operation Windows**

The following sections provide descriptions of the Contact Operation Windows.

6.1.7.1 **SOC Resources Window**

The SOC Resources window allows for an overview of the resources within the operations complex. This window utilizes the color status indicators. Since each complex has different types and numbers of equipment pieces, arrangement of equipment in this window varies between each SOC. The SOC Resources window gives a very general view of equipment pieces and how they are displayed. This window has a one line title bar that is used on most contact operations windows. To exit this window, the user employs the window controls (Para. 4.2.1).

6.1.7.2 Network OPSCAP Status Window

Network status for external resources can be found on the Network OPSCAP Status window. This window utilizes antenna icons on buttons to portray the status of an antenna site with color status indicators. Status buttons allow a user access to more information on the site. To obtain more information, a button activation initiates a window that contains detailed information on the selected piece of equipment. The Network OPSCAP status window uses buttons without icons to depict other resources such as the Defense Communications System/Satellite Control Facility Interface System (DSIS). To exit this window, the user employs the window controls (Para. 4.2.1).

6.1.7.3 Internal Resources Configuration Window

Configuration of the internal resources is accomplished on the Internal Resources Configuration window. This window is available for situations when the automated SSP is not possible or feasible. The window depicts the recommended columnar format. The window uses option menus for configuration choices. Only configurations defined in a vehicle database can be selected. Apply and Cancel buttons are used to execute changes made and to exit the window. This window is specific to an operations complex specific environment. All configurable resources may be displayed here. This window is just an example of how to display such items. Most operations complexes have more items to configure. Toggle buttons are used for selecting yes/no options.

6.1.7.4 Select Contacts Window

The Select Contacts window allows the user to review the scheduled contacts for the complex. The user can select to start a scheduled contact, monitor or take control of a contact, or start a contact that is not scheduled. Pressing the appropriate button activates these functions. Starting or joining a contact is accomplished by selecting a contact from the scrollable list and selecting the appropriate button. The operations concept must be considered when specifying the behavior of actions such as taking control of a contact. Possible implementations may include pop-up windows for the outgoing and incoming users or a pop-up window for flight commander approval. Graying out is recommended for unauthorized user functions. The user may sort the scheduled contacts by clicking on the column heading, which is also a sort label, of the contact list. The sort label functions as a toggle button. The first click sorts the list by the selected column in ascending order and the second click on the column sorts the list in descending order. The help function can be accessed by pressing the Help button. The items displayed in the contact list are definable by the operations complex. Complete contacts can be selected for “no display,” can be displayed in a specified color, or can be shown as “grayed out” as defined by the operations complex. Active contacts can be shown as a specific color or highlighted. An alternative view is to present the contact list in a timeline format. The window control convention is used to exit this window if the user does not start or join a contact. Starting or joining a contact deactivates the Select Contacts window and activates a contact or telemetry window depending on the contact type and pass plan.

6.1.7.5 Initiate Non-SSP Window

This window allows users to add a real-time contact to the schedule using pull down menus and input fields. This window is displayed when the New button is activated on the Select Contacts window. Option menus are used to restrict user selections to items defined in the database. The input field can be populated by previous user selections. For example the ‘Next Rev’ button obtains the data from the orbit propagation and populates the input fields. These fields also accept user input. DSIS and

RTS/ARTS configuration defaults are filled into the input fields once the IRON selection is made. One alternative is to allow for multiple contact type selections by placing items selected from the option menu into a Contact Type List. The contact type option menu is categorized for better organization. This window is displayed until the Begin Contact button (which is available upon completing data input) or the Cancel button is activated. Either button deactivates the current display. The Begin Contact activates the Internal Resources Configuration window.

6.1.7.6 Pre-Pass Brief Window

The Pre-Pass Brief window is an automated, informational display for the operator to use when briefing the site and network connections. The Pre-Pass Brief window is a static window with text fields indicating configurations determined by the SSP or previous operator selections. To exit this window, the user employs the window controls (Para. 4.2.1).

6.1.7.7 Pre-Pass Test Window

The Pre-Pass Test window employs push buttons to launch tests and text fields to display the results. A test is executed by selecting a button of the associated test. The test results appear as text in the output field. The output fields also have status indicators of color to convey the test results. The status indicators give a quick visual color response of the test results. The top of the window depicts a one-line title bar and a menu bar. Cancel and Help buttons are present to exit the function and to obtain help.

6.1.7.8 Contact Summary Window

The Contact Summary window relies heavily on an automated system. The window is dependent on automation because the SSP is executing and the user actions are limited. The user actions are to stop the automation, change the level of automation to manually execute the pass plan, or access another window to edit the pass plan. This window gives an overall picture of the contact. There are static information pieces, such as satellite identifier, contact times, purpose (defined by the SSP), and timing parameters. The contents of the SSP are displayed in a scrollable list. The push buttons with arrows allow the user to increase or decrease the portion of the SSP displayed, allowing the user to view the SSP at a high activity level or at the command level. One option to show contact progress is to change the label on the action button to the left of a command or activity. The example window uses the terms Done, for completed actions, Active, for the current action, or Start, for upcoming actions. The functionality of the push buttons to the left of the SSP item varies depending on the system automation level. The automation level can be changed using an option menu. The Commanding push button activates the commanding window. The Pause, Resume and Abort buttons used on this window pertain to the SSP. This window also shows an example of a two-line title bar. To exit this window, the user employs the window controls (Para. 4.2.1).

6.1.7.9 Contact Monitor Window

The Contact Monitor window is an informational display that shows detailed contact connection data. The color status convention could be added to this window to show an anomalous change to a parameter. The bulk of the information is displayed in text fields. Only one input field and two push buttons are provided for operator interaction. The Antenna Offset input field and Apply Offset push button are utilized only when an offset is necessary to correct the times associated with the antenna pointing angles. The Close button deactivates the window. The OK button is the preferred method of

deactivating this window. Recommended additions to this window are the source of the contact timing and the sync status.

6.1.7.10 Telemetry Display Windows

Text and graphics are used to convey information about the vehicle or the mission on the telemetry windows. Dials, meters, gauges, lines, and arrows are used to make the windows more graphical. Graphical color status indicators and text fields are used to associate telemetry limits. Different views of these items can be found on the Communications, Electrical Power, and Thermal Control windows. The Thermal Control window utilizes the recommended method of displaying limits. Lines and arrows depict the flow of data through a subsystem, as exemplified in Communications and Electrical Power windows. An example of a two-line title bar is displayed on the Vehicle Subsystem window. All of the telemetry window examples utilize the window control convention.

The Attitude and Propulsion windows have static pictures to help the engineer envision the attitude of the vehicle. Pictures of satellites can be used to depict a subsystem or equipment placement on a satellite or a satellite's orientation to the earth. Static pictures can be used with most tools without any coding. Dynamic functions such as orienting the vehicle to the earth require a substantial amount of coding. Some tools may not have widgets defined to allow for such functionality.

6.1.7.11 End of Contact Window

This window returns resources to their systems resource pool. It also deactivates contact functions such as telemetry and contact connections. This window follows the same conventions as the Pre-Pass Test window. This window shows a one-line title bar and a menu bar. The window utilizes the OK, Cancel and Help conventions. Menu bar functions are not repeated with buttons. A link to the log functions is also accessible on this window. Color status indicators can also be used on this window, such as those found on the Pre-Pass Test window.

6.1.7.12 Commanding Window

The Commanding window is used to monitor the progress of the commands sent to the vehicle by the pass plan. The History list shows the number of steps of each command that was received by the vehicle. An option for this list is to show the results of the command, displaying the main telemetry points affected by the command. This list also shows if the command has completed or is still being received. The upcoming command list shows the upcoming commands as defined in the SSP. Future commands are editable from the Commanding – Modify window. Because the Modify button is the access to manual commanding, the SSP pauses upon Modify button selection. There is also push button access to abort the current command as well as to activate the Commanding Modify window. Option menus are used to select the command mode and authorization. A text field is used to display the vehicle command count and a text/input field to display or change ground command count. A push button is used to Send the next command to the vehicle if full automation has been discontinued. The Apply button activates a Ground Command Count change and the Status push button activates the Commanding Status window. Utilize function keys for access to the lower level functions allowing direct access to commanding actions (Para. 6.1.2.1, Arrangement of Windows and Navigation). To exit this window, the user employs the window controls (Para. 4.2.1).

6.1.7.13 Commanding-Status Window

This window shows status of the hardware used on the current contact using the color status indicators. Status buttons labeled with equipment titles allow the user to select more information on each equipment piece by selecting the applicable button. The OK button is used to exit the window. A Close button is the preferred method of exiting this window. Variations such as back-up equipment and alternative connectivity paths could be incorporated into this window.

6.1.7.14 Commanding-Modify Window

This window uses radio buttons to select sorting filters and check buttons to select restrictions. Buttons are used to activate filter and sorting capabilities. Text fields allow for user input to select or search for certain characteristics of a command. Input fields are used to input time tags and display the selected command. An input field allows for user input, default values, and selected input to display in the same field, if supported by the operations concept. An operations concept may require command selection from the command list. The OK, Apply and Cancel buttons are used to implement the modifications or to exit the function. The Apply button allows the user to make multiple changes without leaving the Commanding – Modify window.

6.2 Satellite Mission Planning Conventions

6.2.1 Description

Mission Planning is responsible for all tasks associated with non-real-time scheduling and preparation of supports to meet mission requirements of a satellite constellation. This includes keeping track of schedule-impacting, long-term satellite control network outages, maintaining support requirements catalogs, preparing long-term support schedules for a satellite constellation, and preparing selected Satellite Support Plans.

6.2.2 Screen Layout

Described below is screen layout information regarding arrangement of windows and navigation, rules on overlapping windows, as well as definitions and handling criteria for critical information.

6.2.2.1 Arrangement of Windows and Navigation

Accelerator and function shortcut keys are available for frequently used functions. Examples of functions requiring shortcut keys are in Table 6.3, Mission Planning Shortcut Key Definitions.

Table 6.3. Mission Planning Default Shortcut Key Definitions

| Shortcut Key | Function / Action |
|---------------------|--------------------------|
| Ctrl-R | Support Requirements |
| Ctrl-S | Schedule Change Requests |

6.2.2.2 Rules on Overlapping Windows

Many screens in Mission Planning require a great amount of screen space to be useful. Tiling may be inappropriate for some types of screens such as schedules and resource availability forecasts, which require maximum viewing. Therefore, use cascading screens when multiple windows need to be present on the desktop.

6.2.2.3 Definition and Handling of Critical Information

Critical information specific to Mission Planning may be defined as any significant unexpected event that might require the Mission Planner to change the course of future planning or redo previously completed planning activities. Critical information may include, but is not limited to, schedule changes and mission impacting outages. As described in Para 3.1.3.2, Alert Area, this type of critical information may be displayed by color-coded alarm messages in the Alert Area as well as audible alarms. However, because Mission Planning is by definition a non-real-time activity, none of this information requires immediate action and, therefore, is never presented with confirmation dialog boxes. Another type of critical information is specific to personnel safety or security. This type of critical information follows guidance in 3.1.3.2 of the Alert Area section.

6.2.3 Header Zone

The header zone for Mission Planning utilizes the conventions as described in Para. 3.1.2, Header Zone.

6.2.4 Status Zone

The size of the status zone should be designed to use minimum workspace, allowing more work zone area which is very important to the majority of the tasks in this domain. Described below are Mission Planning specific status zone and alert zone conventions.

6.2.4.1 Status Area

The status area focuses on scheduling related information because of its importance, volatility, and time-sensitivity.

The following components are examples of the content that may be displayed in this area:

- Schedule Change Requests pending for the real-time, conflict, and forecast periods
- Authorized schedule changes for the real-time, conflict, and forecast periods
- Supports affected by unplanned, recent changes in resource availability

6.2.4.2 Alert and Message Area

The alert and message area follows convention guidance described in Para. 3.1.3.2, Alert Area. The following table (Table 6.4, Mission Planning Alert Examples) illustrates examples of alerts:

Table 6.4. Mission Planning Alert Examples

| Criticality | Date/Time | Source | Text |
|-------------|-----------|-----------|---|
| W | 13/2048 | SOC-22 | Working SOC schedule must be submitted in 1 hr |
| W | 14/1832 | SOC-22 | Schedule Change Request for satellite 4592 was denied |
| A | 15/2243 | Sys Admin | System will be going down for maintenance in 30 min. |

6.2.5 **Toolbar**

Listed below are the Mission Planning specific conventions that apply to toolbars:

- The toolbar may be located either above or below the status zone or at bottom of the screen. Although not critical, the placement of the toolbar is below the status area so that blocking of status information never occurs.
- The toolbar should include a method to log-off, print a selected screen, and access help as well as a convenient way to navigate to important areas of mission planning via pull-down menu options.

An example toolbar might contain the following options: File, Scheduling, Support Plans, Resources, and Help.

- The File option contains access to a print and log-off features.
- The Scheduling option contains access to screens for viewing the 24 Hour Schedule, the Working SOC Schedule, the Weekly Planning Schedule by satellite ID, and Schedule Change Requests.
- The Support Plans option contains access to screens for modifying support requirements and generating more specialized support plans such as Maneuver Planning.
- The Resources option contains access to screens for viewing/editing resources availability forecasts and constraints.
- The Help option contains application level help for Mission Planning and follows conventions as described in Para. 5, Help.

6.2.6 **Mission Planning Specific Conventions**

Described below are the Mission Planning specific conventions.

6.2.6.1 Availability Convention

Forecasting future resource availability is essential for Mission Planning. Therefore, a real-time status indicator is insufficient. Instead, availability forecasts should generally follow the status conventions as described in Table 3.1, Color Definitions, and Table 3.2, Color Usage Definitions. Predicted future unavailability or degradation of resources for the time period requested should appear grayed out with the predicted unavailability indicated by a red border and predicted degradation indicated by a yellow border. For predicted complete functionality, the icon (or other item) should have black text and a green border (see status conventions in Table 3.1, Color Definitions, and Table 3.2, Color Usage Definitions). Note that unavailability is not just the reported or predicted operations capability of the resource, but also could include the user's unwillingness to use the resource in question.

6.2.7 Mission Planning Windows

Described below are conventions specific to Mission Planning windows.

6.2.7.1 Support Requirements Window

The Support Requirements window has various option menus for key support parameters that can be changed by the mission planner as mission requirements change. Where there is a choice of many options, an additional pop-up dialog appears. Functions include: Add, Save, Delete, and Help. Some examples of possible complimentary pop-up dialogs containing information follow:

- Support ID Dialog – This dialog contains a scrollable list box of allowable support IDs and several push buttons at the bottom including OK, Cancel, and Help.
- Satellite Configuration Dialog – The Satellite Configuration Dialog contains a scrollable list box of allowable satellite configuration settings and several push buttons at the bottom including OK, Cancel, and Help.
- Additional Hardware Dialog – This dialog contains a scrollable list box of additional hardware selections that can be added to the support requirements and some push buttons at the bottom including OK, Add, Cancel, and Help.

6.2.7.2 Schedule Change Request Window

This window contains all essential information for submitting a change request for a support that has to be coordinated with an external agency. Most of the required information may be selected via option menus. Where this is not practical (such as specifying times) a text field appears. The summary window holds each support change request until the user issues a Delete, Clear All, or Submit command. These commands along with an edit function are accessible by push buttons at the bottom of the window. This screen is not applicable for use with programs that do not need to coordinate their scheduling with external agencies.

6.2.7.3 Twenty-Four Hour Schedule Window

The 24-Hr Schedule contains all the required data for an entire SOC's supports including IRON, remote ground facility (RGF), purpose, start and stop times, resources, and possibly the personnel assigned to the contact. All this information is arranged by default in chronological order for a 24 -

Hour Schedule. Providing an option for arranging supports by other categories such as satellite ID, or RGF may be useful for some programs. This information may be arranged in a tabular fashion. As an alternative display method, the 24-hr schedule may appear as a window with a timeline appearing across the top of the screen, with the various satellite identifiers appearing in sequential order down the left side of the screen. A small bar icon represents each support. The support icon's length and positioning would correspond to the contact duration and start time scaled with respect to the timeline. Each support icon may be accompanied by additional information such as the RGF, start and stop times, pre-pass length (visible by text or visual coding) and a smaller resource icon. Additional information is available by double-clicking the support icon. The resource icon should follow the Availability Convention (see Para. 6.2.6.1, Availability Convention) and might appear as a small button labeled "R" with a status indicator around its border. Additionally, the color of the support icon may distinguish a user-defined attribute such as minimum qualification level to run the support. The look and feel of this window design is very similar to the current Automated Scheduling Tools for Range Operations (ASTRO) system. Some examples of possible complimentary pop-up dialogs containing additional information follow:

Support Information Dialog – This dialog contains additional information on a support such as pre-pass length, start time, duration, time tolerance.

Resource Availability Dialog – This dialog is accessed by clicking the resource icon and contains additional information on the resources available for the selected support.

6.2.7.4 Working SOC Schedule Window

This window follows the same basic design as the graphical version of the 24 Hour schedule. A timeline appears across the top of the screen, with the various satellite identifiers appearing in sequential order down the left side of the screen. A small icon appears for each support similar to the support icon in the 24-Hr Schedule window (see Para. 6.2.7.3, Twenty-Four Hour Schedule Window) but may contain slightly different information depending on mission requirements. Possible information may include RGF, start and stop times, time tolerance, and pre-pass length. Also, any additional information is available by double-clicking the support icon. The look and feel of this window design is very similar to the current ASTRO system. An example of a possible complimentary pop-up dialog containing additional information follows:

Support Information Dialog – This dialog contains additional information on a support such as pre-pass length, start time, duration, time tolerance, and RGF.

6.2.7.5 Planning Schedule Window

The Planning Schedule contains all the required data for a particular satellite, for a given time period (typically a week), arranged in chronological order. Key information would include IRON, start and stop times, time tolerance, RGF visibilities or preferences, resources needed, purpose and any comments or constraints. This way of planning a schedule may be unnecessary if a schedule generator can encompass all the functionality.

6.2.7.6 Schedule Generator Window

The Schedule Generator is an automated method for generating a support schedule. The Schedule Generator window contains all the required routine support types and the frequency with which they must be performed for a given satellite. Additionally, it has a place to insert special support types. Additional constraints should be able to be applied such as specifying the RGF, time window, minimum /maximum elevation angle, non-collocated RGFs, and the ability to treat multiple supports as one suite of supports that follows an all or nothing algorithm for scheduling. When all the information is completed, a button activates the generation of a schedule for a given time period for that vehicle. This window eliminates the need for the more manual Planning Schedule approach. However, manual scheduling may still be preferred for programs that have a lot of specialized needs and exceptions or for programs that have very few support requirements.

6.2.7.7 External Message Window

The External Message Window is a vertically scrolled window containing the details of an externally generated message. Each message includes the originating agency, time tag and sender's identification in the message. This window may be used as an expanded version of a message contained in the alert area of the Mission Planning Status Zone.

6.2.7.8 Maneuver Planning Window

This window contains an option menu selection for satellite identifier and maneuver type. When the user selects a satellite identifier and a maneuver type, the rest of the window fills in with the appropriate satellite specific and maneuver specific configurations as well as an option to import essential parameters such as burn time, burn duration, etc. Some programs may benefit from the additional flexibility of allowing the operator to input data type, time, and duration as a precursor to an external application generating the maneuver plan. When complete, the Mission Planner can select the "Generate SSP" button to complete the fill-ins in the appropriate engineer approved Satellite Support Plan.

6.2.7.9 Resource Availability Forecast Window

The Resource Availability Forecast window contains a world map with important resources represented by hierarchical icons in their respective geographical location. Each hierarchical icon conforms to the Availability Convention (see Para. 6.2.6.1, Availability Convention). An option menu exists for filtering according to a particular family's user defined constraints. A horizontal slider bar is included for selecting a future date of interest and is located in the upper right-hand corner. All the resource icons on the map change to reflect the forecasted availability for the chosen date or range of dates by changing the date in the slider bar.

6.2.7.10 RGF Availability Window

This window is activated in a drill down manner from a hierarchical icon located in the Resource Availability Forecast window. This window contains forecasted availability of the Remote Ground Facility's telemetry, tracking, and commanding capabilities as well as scheduled downtimes and estimated time to return to operation. This window conforms to the Availability Convention (see Para. 6.2.6.1, Availability Convention). The window often overlaps the Resource Availability

Forecast window because it functions similarly to a dialog box.

6.2.7.11 SOC Availability Window

The SOC Availability window is activated in a drill-down manner from a hierarchical icon displayed in the Resource Availability Forecast window. This window contains forecasted availability of the SOC's key operations strings, cryptographic equipment, and mission unique equipment as well as scheduled downtimes and estimated time to return to operation. This window conforms to the availability convention. Also, this window often overlaps the Resource Availability Forecast window because its behavior is similar to a dialog box.

6.2.7.12 Satellite Control Node Availability Window

This window is activated in a drill-down manner from a hierarchical icon located in the Resource Availability Forecast window. A Satellite Control Node may represent any resource or agency, besides RGFs and the operations center that provide mission essential resources or links. For example, Schriever Control contains forecasted availability of its key communication links as well as scheduled equipment downtimes and estimated time to return to operation. This window conforms to the Availability Convention (see Para. 6.2.6.1, Availability Convention). The window often overlaps the Resource Availability Forecast window because it functions similarly to a dialog box. This window is most applicable for programs that use common AFSCN resources or need Schriever Control for external connectivity, but may be used by any program that needs to status a non-RGF control node outside of their operations center.

6.3 Satellite Orbit and Attitude Management Conventions

6.3.1 Description

Orbit and attitude domain activities are related to maintaining each satellite's correct orbit (path through space) and attitude (orientation with respect to the Earth, Sun or other celestial objects). This includes developing orbit and attitude state vectors, generating ephemeris/event products, generating orbit station-keeping and attitude maintenance maneuvers. Also included in the domain is the production of station visibilities, RFI conjunction projections, predictions of close approach to other space objects and interfacing with IRO.

6.3.2 COTS/GOTS Tools

There are many COTS tools available to perform Orbit and Attitude Management functions; these packages vary in their focus and specialization. The developer using these conventions would be well served by reviewing applicable COTS and government off the shelf (GOTS) tools, with the goal of incorporating them and their conventions where it makes sense to do so. Some conventions from Satellite Tool Kit (STK) from Analytical Graphics, Inc., and OASYS from Integral Systems, Inc. are identified in the Developer's Style Guide.

6.3.3 Screen Layout

Described below is screen layout information regarding arrangement of windows and navigation, rules on overlapping windows, as well as definitions and handling criteria for critical information.

6.3.3.1 Arrangement of Windows and Navigation

Listed below are the orbit and attitude specific convention alternatives for arrangement and navigation of windows. The operational unit can select from among these alternatives:

- In the Orbit and Attitude domain, most functions are sequential in nature, beginning with one window and progressing through others. For this reason, windows in this domain provide the names of both the function thread and the window within the tread. The preferred alternative is to name windows by the scheme Thread: Window so as to take up only one line. Another alternative is to have the Thread name on one line and the Window name on another line. This requires two lines (hence, more screen real estate) and is more difficult to develop.
- The preferred arrangement is to default to a scheme where the parent window stays visible in work zone, through perhaps partially or fully covered by other windows, during child window processing with a user option to be able to select the following alternative. Most user comments favor this approach. An alternate approach is for the parent window to disappear from work zone until processing of child window is complete, and then re-appear.
- All windows in sequential processing threads normally have the ability to navigate backward one window in the process, backward to the beginning of the process, and to exit the process completely.
- Accelerator and function shortcut keys are available for frequently used functions. Examples of functions available from shortcut keys are described in Para. 2.3, Navigation Keys and Techniques.

6.3.3.2 Rules on Overlapping Windows

Satellite Orbit/Attitude Management is not directly involved with real-time operations; therefore window overlapping (cascading) is allowed. Refer to Para. 2.5, Use of Multiple Windows on a Single Display, for rules on overlapping windows. As a general rule, children windows should not overlap a parent window.

6.3.3.3 Definition and Handling of Critical Information

This definition and handling of critical information follows the conventions described in Para. 3.1.3.2, Alert Area. There are no critical alerts specific to this domain.

6.3.4 Header zone

The header zone for Orbit and Attitude Management utilizes the conventions as described in Para. 3.1.2, Header Zone.

6.3.5 Status Zone

Described below are the Orbit and Attitude specific status area and alert area conventions. Note: Since the Orbit and Attitude domain does not require very extensive status feedback, a smaller status area and larger work zone is needed. The section below describes status area and alert area conventions.

6.3.5.1 Status Area

Processes and Status are examples of information pertinent to the Orbit/Attitude status area.

6.3.5.1.1 Processes

The Process window is used to display a list of active processes with summary identification of each. Table 6.5 shows Process examples combined with status described below.

6.3.5.1.2 Resource/Activities Status

The latest status message for each process is shown in the alert area adjacent to that process's entry in the Process panel. Double-clicking on a status entry causes a pop-up scroll box to appear providing a history of all the status messages that Process has generated. Table 6.5 includes examples of Processes and their Status.

Table 6.5. Orbit and Attitude Process Examples

| ProcID | UserID | Start | Status |
|--------------------------|--------|--------------|----------------------------------|
| UpdateOrbitStateVector01 | Jdoe | 177/16:19:30 | Iteration 9: Diverged - Aborted |
| ProcessTracking01 | Jdoe | 177/16:20:00 | Error Check: 25 points discarded |

6.3.5.2 Alert and Message Area

The alert and message area follows conventions described in Para 3.1.3.2 Alert Area. The following and Table 6.6 provides category examples of alerts:

- The Alert and Message Area provides system messages, non-specific to active processes, as well as processing error messages pertinent to active processes.
- System message types include: system abends, security alarms, hardware/software problems/updates, networking problems/updates, database problems/updates and system feedback.
- Process error message types include: unexpected end of file encountered, abnormal process termination, process input expected, and other messages necessary for documenting, in a log, problems with the running processes.

Table 6.6. Orbit and Attitude Alert Examples

| Criticality | Date/Time | Source | Text |
|-------------|--------------|--------|------------------------------------|
| W | 194/16:20:25 | 1234 | Unexpected end of file encountered |
| W | 194/16:20:29 | 1234 | Tracking data not processed |

Examples of sources in Table 6.6 are IRONs, satellite identifiers, equipment, processors, external dependencies, etc.

6.3.6 **Toolbar**

Listed below are the Orbit and Attitude specific conventions that apply to toolbars:

The placement of the toolbar is not critical (top/ bottom of status area or bottom of screen)

Menu Items – order choices by functional groups or frequency of use.

- File – Print and Logoff
- Orbit – Process Tracking Data, Update Orbit State Vector and Generate Orbit Products
- Attitude – Process Attitude Data, Update Attitude State Vector and Generate Attitude Products
- Database – Maintain Database, Maintain Controls, Enter New IRONs (satellite identifiers) and Import and Export Orbit and Attitude Data
- Maneuver Planning – Initiate Orbit and Attitude Maneuver Planning
- Program-specific – Constellation Management and Other Program-specific Functions
- Help – General help for system and Orbit/Attitude functions.

6.3.7 **Orbit and Attitude Management Specific Conventions**

Described below are the Orbit and Attitude Management specific conventions.

- Classification Issues: Inclusion/combinations of certain fields can make the window content classified. The following possible alternatives may be utilized:
 - a) Exclude fields and prevent associations in order to maintain an unclassified environment.
 - b) Substitute unclassified designators for entities whose inclusion would make a window classified.
 - c) Accommodate classified windows with proper controls, procedures and markings. Ensure that the operator/viewer has proper authority to view classified screens by password or other control method. Multiple-level security environment must be given consideration.
- Store/Recall Issues: satellite programs need to devise a store/recall convention whereby filenames and/or properties are used in a way that quickly identifies important characteristics of the file. These characteristics could then be searched on upon subsequent recall procedures. An example of file properties follows the Properties sheet attached to Microsoft® Word® documents. As an example of a file naming scheme for tracking data files, the following is suggested:

IRON date site-side condition with:
IRON: four digit IRON date: date in YYYYMMDD format
site-side: RGF antenna taking the data
cond: raw or proc(essed)

- Common Conventions: Orbit and Attitude domain windows use the conventions described in Sections 1 through 5 with a few additions as described under the appropriate windows. In general, widgets have been selected to minimize required operator effort and typing, and to circumvent input errors. For example, combo boxes, which embody pull-down lists, are predominant for the selection of IRONs. But they also allow the operator to type in the IRON of interest, if he/she so chooses. In this manner, an operator can use whichever method he/she finds most efficient.

6.3.8 **Orbit Management Windows**

The following windows are used for Orbit Management.

6.3.8.1 **Process Tracking Data**

The following windows are related to processing tracking data to be used in updating the orbit state vector.

6.3.8.1.1 **Process Tracking Data Window**

This window is used to process tracking data by error checking and thinning. An Orbit-specific widget used for input in this window is the Linked input field. Linked input fields σ - % (sigma – percentile), are such that σ is linked with % such that an entry in the σ field generates an entry in the % field that is the percentile corresponding to that σ , and vice-versa. Using this widget, an operator can input error limits in either sigma values or percentiles, whichever he/she prefers, and the corresponding value in the other units is displayed automatically.

6.3.8.1.2 **Select Tracking Data Sets Window**

This window allows the user to select tracking data sets by name, time span or rev span. It is in response to user comments requesting the ability to select tracking data sets by time span, and to be able to view, edit, or deselect specific tracks. Note that this window is also related to updating the orbit state vector.

6.3.8.2 **Update Orbit State Vector Windows**

The following windows are related to updating the orbit state vector.

6.3.8.2.1 **Update Orbit State Vector Window**

This window allows the user to update the orbit state vector by selecting an IRON; it uses defaults for all other parameters. It is in response to user comments requesting expanded use of defaults in simplifying Orbit operations. For scenarios where access to more processing details is required, it provides access to windows for both controls and estimation details.

6.3.8.2.2 Update Orbit State Vector: Controls Window

This window allows the user to modify controls used to update the orbit state vector. It provides access to detailed and varied controls used in state vector update processing.

6.3.8.2.3 Orbit State Vector: Estimation Window

This window provides the user access to details in the orbit estimation process. It provides access to “hands-on” state vector update processing. It also provides more extensive results than the Update Orbit State Vector window.

6.3.8.2.4 Update Orbit State Vector: Residual Editing Window

This window allows the operator to graphically edit residuals. Graphical residual editing is much preferred to editing tables of numbers since residual patterns are not evident from such tables whereas they are immediately visible in a graph.

6.3.8.3 Generate Orbit Products

The following windows are related to generating orbit products.

6.3.8.3.1 Generate Orbit Products Window

This window allows users to generate Orbit products, such as Ephemeris and Events, Antenna Pointing Angles, Station Accesses, RFI conjunctions, etc.

6.3.8.3.2 Orbit Ephemeris and Events Window

This window allows the user to generate Orbit ephemeris and events. The use of tabs in the window allows multiple views to be compacted into one window, making it easier to manage a fewer number of windows. This example includes a menu bar common to all tabs.

6.3.8.3.3 Orbit Ephemeris and Events Window: Orbit State Tab

This tab allows the user to set the orbit state to be used in ephemeris propagation and events generation.

6.3.8.3.4 Orbit Ephemeris and Events Window: Report Controls Tab

This tab allows the user to set controls on how the report is to be generated.

6.3.8.3.5 Orbit Ephemeris and Events Window: Ephemeris Controls Tab

This tab allows the user to set controls on the generation of ephemeris. Widgets used for input include spin buttons on fields of related parameters that are linked in such a manner that changing one parameter changes the other linked parameters accordingly.

6.3.8.3.6 Orbit Ephemeris and Events Window: Events Controls Tab

This window allows the user to set controls on the generation of events. Widgets used for input

include a pick-and-put linked to toggle buttons. This linkage is such that selecting a toggle button causes the corresponding parameters to move from the “Available” side of the pick-and-put widget to the “Selected” side.

6.3.9 Attitude Management Windows

The following functions reside under the Attitude menu.

6.3.9.1 Process Attitude Data

The conventions for Process Tracking Data under the Orbit menu are directly applicable to this function due to the similarity of operations.

6.3.9.2 Update Attitude State Vector

The conventions for Update Orbit State Vector under the Orbit menu are directly applicable to this function due to the similarity of operations.

6.3.9.3 Generate Attitude Products

The conventions for Generate Orbit Products under the Orbit menu are directly applicable to this function due to the similarity of operations.

6.3.10 Database Windows

This menu leads to the Maintain Database, Maintain Controls, Enter New IRON (satellite identifier), Force Model Controls and Station Parameters options.

6.3.10.1 Import Orbit/Attitude Data Windows

Windows for Import Orbit/Attitude Data follow:

6.3.10.1.1 Import Orbit/Attitude Data: Source and Type Window

This window allows a user to import Orbit/Attitude data. Data source and type are selected here.

6.3.10.1.2 Import Orbit/Attitude Data: State Vector Windows

This window allows the user to import Orbit State Vector data.

6.3.10.1.3 Keplerian Elements Window

This window allows a user to import Orbit State Vector data in Keplerian Elements.

6.3.10.1.4 Import Orbit/Attitude Data: Maneuver Window

This window allows a user to import Orbit/Attitude Maneuver data.

6.3.10.2 Export Orbit/Attitude Data Windows

Described below are conventions specific to Export Orbit/Attitude Data windows.

6.3.10.2.1 Export Orbit/Attitude Data: Destination and Type Window

This window allows the user to export Orbit/Attitude data. Data destination and type are selected here.

6.3.10.2.2 Export Orbit/Attitude Data: Orbit Events Window

This window allows a user to export Orbit Events data.

6.3.10.2.3 Orbit Events: Report Window

This window allows the user to export Orbit Events data for selected events.

6.3.10.3 Force Model Controls Windows

The following are windows pertaining to force model controls.

6.3.10.3.1 Force Model Controls Window

This window allows the user to set force model controls.

6.3.10.3.2 Orbit Maneuvers Window

This is another window with which to import orbit maneuvers.

6.3.10.4 Station Data Windows

6.3.10.4.1 Station Parameters Window

This window allows user to set/modify station parameters. Selecting any one of the four check boxes, Position Data, Obscra Data, Measurand Data, and/or Other Station Data, brings up a window specific to that data. Any or all check boxes can be selected at any time, resulting in windows corresponding to all options selected.

6.3.10.4.2 Station Parameters: Position Data Window

This window allows the user to set/modify station position parameters, such as latitude, longitude, elevation, and their corresponding uncertainties.

6.3.10.4.3 Station Parameters: Obscra Data Window

This window allows a user to set/modify station obscura parameters, which basically are minimum elevation angles for visibility as a function of azimuth.

6.3.10.4.4 Station Parameters: Measurand Data Window

This window allows the user to set/modify station measurand parameters, which are biases and uncertainties related to antenna measurements.

6.3.10.4.5 Station Parameters: Other Station Data Window

This window allows the user to set/modify other station parameters, such as refraction correction coefficients, ionospheric and tropospheric delay parameters, etc.

6.3.11 Maneuver Planning Windows

Described below are conventions specific to Maneuver Planning windows.

6.3.11.1 Orbit Maneuver Planning Windows

The following windows implement maneuver planning functions for one type of orbital maneuver: East-West Station-keeping.

6.3.11.1.1 Orbit Maneuver Planning Window

This window allows a user to select an IRON and maneuver type, and plan the maneuver and generate maneuver parameters.

6.3.11.1.2 Orbit Maneuver Constraints Window

This window allows the user to set special maneuver constraints, such as maximum delta-V, maximum propellant used, etc.

6.3.11.1.3 Orbit Maneuver Results Window

This window allows the user to view numerical results of the maneuver plan. It also provides access to a graphical results window.

6.3.11.1.4 Orbit Maneuver Graph Window

This window provides graphical depiction of E/W station-keeping maneuver results. Widgets used for output include a graph.

6.4 Satellite Engineering Analysis Conventions

6.4.1 Description

The Satellite Engineering domain provides the technical details necessary to operate complex satellite systems. This includes, developing, validating and maintaining a library of SSPs, monitoring the state of health of assigned satellites, developing anomaly resolution plans/satellite safe-mode procedures, and assisting in out-of-procedure anomaly resolution.

6.4.2 Screen Layout

Described below is screen layout information regarding arrangement of windows and navigation, rules on overlapping windows, as well as definitions and handling criteria for critical information.

6.4.2.1 Arrangement of Windows and Navigation

Accelerator and function shortcut keys are available for frequently used buttons. Examples of functions requiring shortcut keys are in Table 6.7 Engineering Analysis Default Shortcut Key Definitions.

Table 6.7. Engineering Analysis Default Shortcut Key Definitions

| Shortcut Key | Function / Action |
|--------------|-----------------------------------|
| F3 | Schedules submitted to scheduling |
| F4 | Future Schedules |
| F5 | Planned Maneuvers |

6.4.2.2 Rules on Overlapping Windows

Engineering analysis is not directly involved with real-time data management, therefore window overlapping (cascading) is allowed. Refer to Para. 2.5, Use of Multiple Windows on a Single Screen Display, for more information.

6.4.2.3 Definition and Handling of Critical Information

The definitions and handling of critical information follows the conventions described in Para. 3.1.3.2, Alert Area. Refer to this paragraph for examples.

6.4.3 Header Zone

The header zone for Engineering Analysis utilizes the conventions as described in Para. 3.1.2, Header Zone. The information items that are the most useful for this domain are classification and operational mode.

6.4.4 Status Zone

The status zone is made up of the status area and the alert area. The section below describes Engineering Analysis specific status area and alert area conventions.

6.4.4.1 Status Area

The status area contains information pertinent to the Engineering Analysis functions. The following components are examples of the content that may be displayed in the status area.

This area may be comprised of a schedule of upcoming and current contacts. The schedule typically shows contact specific information such as start time, stop time, RTS/Type, front end processor (FEP), Mode, Purpose, and the operator assigned to the contact. The schedule can be sorted by column headings. The sorts can toggle between ascending order and descending order as a title heading is clicked.

Another possible implementation of the status area is to use a smaller schedule. The number of columns displayed in the schedule could be reduced. The decreased schedule size allows for buttons with direct access to windows. Examples of the types of windows accessed by a button are network resources status, long term vehicle planning, or working SOC schedule.

6.4.4.2 Alert and Message Area

The alert and message area follows the conventions described in Para. 3.1.3.2, Alert Area. The source of the alert can be:

- IRON, such as 1234
- Flight Number, such as Family 1 vehicles
- Vehicle subsystem, such as Guidance
- Ground equipment, such as ARTS

Table 6.8 provides examples of alerts:

Table 6.8. Engineering Analysis Alert Examples

| Criticality | Date/Time | Source | Text |
|-------------|--------------|--------|---|
| A | 149/00:45:00 | 1234 | Parameter Heater A not found in database |
| W | 149/00:42:00 | 1234 | L-Limits w/in 5 degrees of H-Limit |
| E | 149/00:41:00 | 1234 | Parameter A Side Status Limit Set updated |
| E | 149/00:40:00 | 1234 | Eclipse Trending Set Activated |

6.4.5 Toolbar

The placement of the toolbar is not critical, because operations in this domain are not time critical. Listed below are the Engineering Analysis specific conventions that apply to menu items in the toolbar:

- Playback - Telemetry and Trending
- SSP - Editing and Creating
- Sets – Trending and Limit
- Block Command – Maintenance

- **Derived Telemetry** – Editing and Creating.

6.4.6 **Engineering Analysis Specific Conventions**

The section below describes conventions utilized in Engineering windows:

6.4.6.1 **Automatic Data Selection**

The Automatic Data Selection convention uses system or user input to populate other input fields. The example used in this area utilizes a file naming convention (e.g., Julian date/time_IRON) to select other parameters (IRON). For example, if the user selects the 001/0001_1234, the function automatically selects the 1234 IRON. This feature minimizes the number of selections that the user has to make. This is the only domain that utilized this common function.

6.4.6.2 **Radio Button and Option Menu Group**

Radio buttons are used to make a selection of a category. An option menu, associated with the selected button, is used to make specific choices within a category. This convention is used extensively in this domain.

6.4.6.3 **Pick-and-Put and Identifier Group**

This convention combines the functionality of pick-and-put buttons with an option menu. The pick-and-put function is used to move data items between lists. The option menu is used to attach an identifier to the data items. When the data item is selected an identifier is added to a data item and both are moved to the new list. This is the only domain that utilized this specific convention.

6.4.6.4 **Positional Pick-and-Put Buttons**

This convention is used in conjunction with the directional arrow pick-and-put and identifier group convention. It provides additional push buttons for repositioning items in a list. An item in the list is selected and the up arrow is activated to move the item up one position in the list. The down arrow button activates the opposite behavior. If the item is at one end of the list and the next button activation would remove the item from that end of the list, the item is allowed to “wrap around” to the other end of the list. For example an item at the top of the list is selected. The user activates the up button and the item then appears at the bottom of the list. This is the only domain that utilized these specific functions of the pick-and-put convention.

6.4.7 **Engineering Analysis Windows**

The section below describes conventions utilized in Engineering Analysis Windows.

6.4.7.1 **Edit/New Trending Sets Window**

This window allows a user to update or create a trend set. A trend set is a collection of telemetry parameters that pertain to one area of the vehicle. The trend set is recorded to obtain a history of one area of the vehicle data that is easily viewed by the user. This window uses a version of ‘pick-and-put’ that depicts adding another descriptive parameter when the data is moved to the destination list. To use this version of the pick-and-put, the user chooses to add a timer (every X duration). For this

window, the timer defines the number of times a parameter is recorded. The timer defines the number of times a parameter is recorded. The duration timer value does not change unless the user changes it. Items are copied from the source list (Available Parameters) to the destination list (Selected Parameters). If multiples of the same item are not allowed in the list being created, once the item is moved into the new list it is deleted from the source list. There is a time span on the history data for the user to define the duration of the history table or graph. The user defines the start time by day, month, year, and hour. The duration input field accepts numeric data and an option menu contains the interval selections such as minutes, hours, days, etc. There are buttons to access windows to view the history of the trend set in a table or graph format. A Limit Set button allows access to the limit set windows. The Save and Close buttons follow the definitions described in Table 4.1, Common Button Actions.

6.4.7.2 Build New Satellite Support Plan Window

This window uses a version of pick-and-put to move data items between the source and the destination list. An additional feature is the positional pick-and-put buttons to reorder data items in the destination list. The selected or highlighted item in the component list is moved by selecting the up or down arrow. The item moves once for each arrow selection. For convenience ‘Definition of Data’ is used to describe items in the available component list. The ‘radio button and option menu group’ convention is used to select the SSP scope. The Validate button verifies that the components are in a logical and operationally sound execution order. The Approve button verifies that the component has been reviewed and is ready for operational use. The Save and Close buttons follow the definitions found in the Table 4.1, Common Action Buttons. Recommendations for this window are:

- Adding a time tag function
- Adding a flow charting tool to build and edit the SSP
- Capability to viewing another SSP to help in building a new SSP.

6.4.7.3 SSP Build Satellite Block Commands Window

This window uses the pick-and-put convention to move individual commands into a block command list. Positional pick-and-put buttons allow the user to change the order of a selected item (up or down in the selected list). This is used whenever the order of the items carries a significance, such as command order. The user can change which item is selected by using the mouse to select (click on) another item. To move up and down the list once the initial selection is made, the directional arrow pick-and-put buttons are employed. Source lists are structured in descending order. The Validate button verifies that the components are in a logical and operationally sound execution order. The Approve button verifies that the component has been reviewed and is ready for operational use. Response to these functions could be accomplished with a pop-up response window. The Save and Close buttons follow the definitions described in the common action buttons are utilized on this window. The drag-and-drop convention is an alternative method for pick-and-put. A design consideration of the drag-and-drop convention is that it may require a substantial amount of coding for some COTS tools to implement.

6.4.7.4 Space Vehicle (SV) Limit Set Window

The SV Limit Set window uses scrollable lists to display available and active limit sets. Only one list can have focus at one time to alleviate confusion. A number is typed into the expiration interval input field. An option menu contains the time span for the expiration interval. An example is: a 2 is typed into the input field and a selection of ‘days’ is made in the option menu. This defines the limit set to expire in two days. To activate a limit set the limit set is selected, an expiration interval is defined, if desired, and the Add to Available List button is selected. This function adds the limit set to the Active Limit Set List. To create a new limit set the user chooses the desired scope from the option menu, and inputs the name into the Limit Set Name input field and activates the Edit/New button. If a previous limit set is selected the name appears in the Limit Set name input field. A limit set is selected and the Edit/New button is activated to obtain the Edit/New Limit set window. The Import button allows for limit sets from other databases or systems to be copied and used for another vehicle. The Apply, Edit/New, Delete and Close common action buttons are utilized on this window.

6.4.7.5 Import Limit Set Window

The following paragraphs describe variations of conventions for creating import windows.

Variation 1: The import limit set window allows for limit sets from other databases or systems to be added into a database. This window is a dialog box automatically created by the tool. Some tools, such as UIM/X, create basic dialog boxes. The dialog contains basic functions but may not allow the developer to change common features such as color. The inability to make changes to the dialog box may make the dialog box noncompliant with defined conventions. There are buttons to activate functions such as OK, Filter, Cancel, and Help. One advantage of this implementation is that the code to perform these functions is created with the window.

Variation 2: A window that has the look of a dialog box but is created by the user can be edited by the user. The user is able to change the size of each item and the color combinations. There is an input field for file specification, scrollable list boxes display directories and the files in the directories, and a text field to display a selection made in the scrollable file list. Only the most recently selected directories are visible to the user. There are buttons to activate functions such as OK, Filter, Cancel, and Help. To implement these functions more coding is required.

6.4.7.6 Edit/New Limit Set Window

This window uses multiple input fields, an option menu, and a push button to define a Limit set. The user types in the parameter name and the limits in the input fields. An option menu contains engineering unit selections defined for the system to define the parameter. The Add/Update Parameter button is pressed when all of these inputs are completed. A scrollable list box displays the parameters defined for the limit set. A sorting function for the list of limit parameters allow for organization by subsystem. The Trend Set button accesses the trending windows. The Save, Delete, Clear, and Close buttons follow the definitions in Table 4.1, Common Button Actions.

6.4.7.7 SV Trending Set Window

The Trending Set window uses scrollable list boxes to display the available and active trending sets. An input field is available to display the selected trend set or to input a new trend set. A time interval is defined by the day, month, year, hour, and duration input fields. The order of these items can be changed. For example, some operations rooms prefer month, day, year. The duration input field accepts numeric data and the time span is selected from the option menu (hours, days, weeks, etc.). There are push buttons to access the edit window, delete a trending set, import a trending set, or cancel the function. The Limit Set Scope default to the Vehicle, with the IRON input field (added to the window) is left blank. Permanent data, such as default trend sets, can be specified by the system as not available for deletion. The function to delete permanent data can be identified with a pop-up window and a message stating that the data cannot be deleted.

6.4.7.8 Telemetry/Trending Playback Window

This window utilizes toggle buttons to specify the type of playback: trending or telemetry. Automatic Data selection convention is utilized. The IRON from the File Set selection window is identified and placed into the IRON input text field by the system. The user can still type an IRON into the IRON input field. An input text field allows the user to define the date of the desired playback data. Radio buttons are used to select the report type. The 'None' button behaves like a toggle button; when it is selected all other buttons are de-selected. The 'Commanding', 'Telemetry', and 'Trending' buttons act as radio buttons, one or more can be selected at one time. The raw telemetry data can be processed utilizing different limit and trend sets. The limit and trend sets have default values but can be changed by the user. The playback rate processes the data at different rates ranging from one half of real time to twice the speed of real time. Buttons are used to activate the process or to cancel the function.

6.4.7.9 Block Command Maintenance Window

A scrollable list box is used to select the block command the user wants to edit. There is a text field to input a new block command or display the selected block command. Push buttons are used to activate the Edit, Delete and Close functions.

6.4.7.10 SSP Main Window

A scrollable list box is used to select the SSP the user wants to edit. A text input field is used to input a new SSP description. This input field is also used to view or to edit the current description of the selected SSP. The Save Description button allows the updated description to be stored on the system. A text input field is available to type in a new SSP name or to display the selected SSP. Import, Edit, Delete, and Cancel capabilities are accessible by a button.

6.4.7.11 SSP Components Window

Common command and directive combinations can be placed into a component. This allows for these combinations to be added to an SSP as a whole instead of many small parts. The component is part of a concept of creating SSPs in a modular format. Three scrollable list boxes display the items in the component, available commands, and available directives. The pick-and-put method is utilized to move data items for component creation or editing a component. Push buttons are used to activate the validate and approve functions. The Validate button verifies that the component items are in a logical and operationally sound execution order. The Approve button verifies that the component has been

received and is ready for operational use. Push buttons are used to Close the window and to Save the updated component.

6.4.7.12 Derived Telemetry Window

A derived telemetry point is a parameter that uses different bits in the wavetrain to create a parameter not defined in the wavetrain. This window uses toggle buttons to define the scope of the parameter. An option menu contains a list of derived telemetry points. Spin boxes are used to select a wavetrain and a parameter type. There are option menus to select the parameter bit length and algorithm used to create the derived parameter. Input fields are used for the input parameters that define the wavetrain word used to define derived telemetry point. The OK, Apply, Delete, and Close buttons follow the definitions described in Table 4.1, Common Button Actions.

6.4.7.13 Match/Set Bits Window

This window uses option menus and input fields to define the parameter bits that create the derived parameter bits. The window repeats the inputs 8 times to define 8 bit positions. Because most parameters are defined in multiples of 8, the Next 8 Bits button allows access to another version of the window. The difference is that the next display defines bits 9-16. Consecutive windows are accessed depending on the size of the parameter defined on the Derived Telemetry window. The OK, Apply, and Cancel buttons follow the definitions of the Common Button Actions described in Para. 4.2.3.5.5, Common Action Buttons.

6.5 Satellite Mission Payload Operations Conventions

6.5.1 Description

The tasks required to perform Mission Payload Operations include data receipt, processing, analysis, and dissemination. Although the processing and analysis functions relate primarily to the mission data itself, unique display requirements may also exist for monitoring and controlling payload sensors and on-board processes. Because both of these areas are highly mission unique, the intent of this section is to identify conventions that are common among programs and can be applied to all equally. The conventions associated with this domain are therefore at a higher level than the other domains. For most functionality, the conventions already defined are sufficient. Another rationale for the high level of this domain is the uniqueness of the payloads themselves. Examples of different types of payloads that would need to be supported are: Navigation, Communications, Weather, and Surveillance. The conventions captured for this document reflect the review of payload operations' screens from GPS, DSCS, and SBIRS.

6.5.2 Screen Layout

Described below is screen layout information regarding arrangement of windows and navigation, rules on overlapping windows, as well as definitions and handling criteria for critical information.

6.5.2.1 Arrangement of Windows and Navigation

Arrangement of windows and navigation utilize the high-level conventions described in Para. 2, Operator Interaction, and Para. 4, Windows. However, unique requirements of a specific payload necessitate that each program determines the low-level requirements.

Those windows containing critical information should not be allowed to be made into icons. Each satellite program needs to identify “critical data” and restrict the appropriate windows from being iconified. Windows that do not contain critical information can be iconified, as determined by the individual satellite program.

Shortcut keys are available for frequently used functions. (See Para. 2.3, Navigation Keys and Techniques). The following is one example specific to Mission Payload:

Build Upload: Payload specialists in a satellite program like GPS need to be able to make corrections to on-board data and processes quickly. Having a function key or “hot key” that allows instant access to the screens required to build an upload to a specific satellite is desirable. This key could be available from Payload Operations, Contact Operations or Engineering Analysis, depending on program requirements.

6.5.2.2 Rules on Overlapping Windows

For the following reasons, a non-overlapping or tiled convention for window placement is recommended in the Payload Operations domain:

- Payload Operations is a real-time domain that frequently requires more than one window be opened for simultaneous viewing.
- Timeliness of operator actions also requires that operator window manipulation or placement be reduced or eliminated.
- Operator screen management and extra steps are typical of overlapping or cascaded windows.

This design convention does allow for dialog and feedback windows to appear on top of (or overlapping) the current window when an operator action is required prior to leaving the window or continuing to the next step.

6.5.2.3 Definition and Handling of Critical Information

Critical information in mission payload operations can include anything that prevents the mission from being accomplished or which poses a danger to personnel. Some examples are: satellite anomalies, ground anomalies, communication outages, degradations or failures related to the payload mission, fire alarms, emergency messages, and so forth. As described in the Para. 3.1.3.2, Alert Area, critical information is color-coded and may be accompanied by an audible notification, appear in a dialog window or may be displayed in the alert area as a message. Operator notification of critical data requires operator action/acknowledgment.

6.5.3 Header Zone

The header zone for Mission Payload Operations utilizes the conventions as described in Para. 3.1.2, Header Zone.

6.5.4 Status Zone

Emphasis is concentrated on reducing the size of the status zone as much as possible, allowing the most workspace possible. The section below describes Mission Payload Operations specific status area and alert area conventions.

6.5.4.1 Status Area

Content requirements are mission unique and are determined by each satellite program. Examples of data relevant to this area includes: Constellation Status, Payload Status, Ground System Status, Data Quality, and OPS CAP. The components that comprise the Mission Payload Operations Status Area should be clearly labeled to identify the data presented.

6.5.4.2 Alert and Message Area

The alert and message area follows the conventions described in Para. 3.1.3.2, Alert Area. Specific alerts for Mission Payload are mission unique and are supplied by the individual program. Examples of possible Payload Operations alerts are in Table 6.9. Contents of the ‘Source’ column may include: IRON, flight number, equipment name, external user, launch number, process ID, etc.

Table 6.9. Mission Payload Operations Alert Examples

| Criticality | Date/Time | Source | Text |
|-------------|--------------|--------|------------------------------|
| A | 194/00:39:26 | XXXX | Loss of signal from Sensor C |
| A | 194/00:42:31 | 1234 | Guam-B down for maintenance |
| W | 194/00:41:32 | 1111 | Sensor B temp out of limits |
| E | 194:01:05:41 | 2222 | Upload complete |

6.5.5 Toolbar

Toolbar placement can be either below the status zone or at the bottom of the screen (care must be taken to choose a location which avoids a situation in which critical data is covered by the toolbar menus when open).

Listed below are the Mission Payload specific conventions that apply to menu items in the toolbar:

- **File** - To include save, save as (as required) print and exit
- **Payload** - To include Mission Operations, Payload Operations, and Playback
- **Analysis** - Screens and software packages required to perform Mission and Payload Operations by a particular program to include histograms, trending graphs, and alert history.
- **Reports** - Forms, logs, reports and history files required by a Program
- **Help** - General help for Mission/Payload Operations.

6.5.6 Mission Payload Specific Conventions

Mission Payload specific conventions are mission unique and are identified by each satellite program.

6.5.7 Mission Payload Windows

Described below are conventions specific to Mission Payload windows.

6.5.7.1 Multi-Payload Window

A hierarchical tree structure is used to provide a high-level status display for payload components. Payload Selection is available from toolbar, if not defaulted by sign-on sequence. Conventions for indicating status on buttons, as described in Para 3.2.1, Usage of Screen Colors, are followed. The widget used for this example is an on-line system button using a combination of border color and fill to represent the status of the system.

6.5.7.2 SV Memory Status

This window provides status of the contents of a specific SV's central processing unit (CPU) and memory. Widgets used for this example include the following: a single line title bar, scrollable list boxes to easily access desired memory address locations, and a spinner box to select the CPU desired.

6.5.7.3 Payload Status Window

The Payload Status Window is an example of how to display the status of an SV's payload subsystem. Payload Status is available from toolbar, Contact Operations, or Engineering Analysis. The following are examples of Mission Payload Operations specific implementations of conventions which can be used in this window: two line title Bar (used as an example to display the type of contact and still have room for site, time SV, etc. without getting cluttered). This is an example of output fields using a combination of border color and fill to indicate status, a scrollable table, and navigation push buttons. The scrollable table allows for easy access to telemetry data for large subsystems where the data does not fit on one screen. The navigation push button provides access to a schematic diagram of the subsystem for analysis.

6.5.7.4 Mission Operations Window

The Mission Operations window is a placeholder for a Main Mission Operations screen that would be used as a default screen for Mission Operators. Windows are to be provided by each Satellite Program.

6.5.7.5 Mission Payload Tasking Window

The Mission Payload Tasking Window is an example of a window used to display a daily schedule of tasks required for a payload specialist. The tasking window is available from the toolbar. Examples of Mission Payload Operations specific implementations of conventions which can be used in this window are as follows: single line title bar (used to show an example of a one-line title bar, two-line title bars can be used when you have a lot of information to convey and do not want it to be cluttered), check buttons used by the operator as a means of filtering a schedule of daily tasks, and a scrollable list box used to display the schedule of tasks.

6.5.7.6 Build Payload Upload Window

This window represents an example of a Build Upload screen that may be used by a program to upload payload specific data to a satellite. Build Payload Upload is available from the toolbar and from Contact Operations. Listed below are examples of possible Mission Payload Operations specific implementations of conventions which can be used in this window: a scrolled list is used to select the SV of interest, radio buttons are used to select the upload type, and input fields are used to request upload start time and span of upload.

As an option, this window can include a command dialog used in conjunction with command line entry field (see Para 6.1.7.12, Commanding Window).

6.5.7.7 Schematic Diagram

This window is provided as an example of how to display schematic diagrams. The only widget shown is a scrolled window, used to accommodate displaying large diagrams on a single screen.

6.6 Satellite Operations Support Conventions

6.6.1 Description

Operations Support includes functions which are required to maintain operations but which are not directly related to operational control of satellites. The areas included in this domain are System Administration, Security Management, Database Management, and Training/Simulation for satellite operations. Each of these are described in the sections below.

6.6.1.1 System Administration

Listed below are the Operations Support specific functions that apply to System Administration:

- The System Administration windows follow COTS tool conventions. All system administration windows were derived from the system administration tools delivered with the operating systems for the following companies: International Business Machine (IBM), Sun, Hewlett Packard (HP) and Digital Equipment Corporation (DEC).
- A high level analysis was performed on each tool's functionality and GUI techniques were analyzed. A detailed COTS trade study was not performed. Listed below are the comparable COTS Tools:
 - a) **IBM's Advanced Interactive Executive (AIX)** - Uses toggle buttons for all windows, while utilizing a drill-down capability. A drill-down capability requires the user to open one window to get to another window. IBM's AIX uses limited graphics, provides lots of functionality, but as a result of the drill-down capability, requires lots of windows. The GUI in this tool is average.
 - b) **Sun's Solaris** - Uses icon/push buttons for the main window, with some drill-down, and limited use of graphics. Additional functionality is available with purchase/add-on of

additional Solaris tools. The GUI in this tool is good.

- c) **HP's Unix (UX)** - Uses icon/push buttons for the main window, with some drill-down, and limited use of graphics. No information available, at this time, on functionality. The GUI in this tool is good.
- d) **DEC** - Uses icon/push buttons for main window. The tool that comes with the operating system has limited functionality. DEC utilizes combo boxes/drop down menus, and as a result, minimizes the number of windows required to perform a particular function. The GUI in this tool is very good.

6.6.1.2 Security Administration

Listed below are the Operations Support specific functions that apply to security administration:

- The security administration windows follow COTS tools conventions and are derived from COTS products, as well as specialty COTS security tools.
- All security administration windows meet all the functionality of the system administration tools analyzed; however, they may not meet all the functionality for specialty security tools.

6.6.1.3 Database Administration

Listed below are the Operations Support specific functions that apply to database administration:

The domain team performed a high-level analysis on several COTS databases to include: Oracle, Sybase, and MicroSoft (MS) Access. The results of this analysis determined that the database products have built-in tools that meet the functionality of the HMI Functional Task Analysis. Therefore, focus was placed on unique satellite database requirements to include: problem tracking/reporting, and certain utility functions that can be used to modify database options.

6.6.1.4 Training/Simulation

Listed below are the Operations Support specific functions that apply to training/simulation:

- The training/simulation function under Operations Support focuses on the windows to be used by the trainer. The student/trainee would use the same windows and thus the same conventions as the domain for which they are training (e.g., Contact Operations).
- A tab convention is used in the design of the training windows to combine the Plan Sim, Run Sim, Playback Sim, and Update Student Database functions. As a result, the number of windows is transparent to the user, and appears to be minimized.

6.6.2 Screen Layout

Described below is screen layout information regarding arrangement of windows and navigation, rules on overlapping windows, as well as definitions and handling criteria for critical information.

6.6.2.1 Arrangement of Windows and Navigation

Listed below are the Operations Support specific conventions that apply to the arrangement of windows:

- Operations support is not a real-time activity. As a result, window layout is more flexible and overlapping as well as resizing of windows is allowed.
- The ability to access network activities whenever possible for all functions has been and should be incorporated.
- Shortcut keys are to be available for frequently used functions. See Para. 2.3, Navigation Keys and Techniques, for shortcut key examples. At this time, there are no Operations Support specific shortcut keys.

6.6.2.2 Rules on Overlapping Windows

Operations Support is not directly involved with real-time data management, therefore window overlapping (cascading of windows) is allowed. Refer to Para. 2.5, Use of Multiple Windows on a Single Screen Display.

6.6.2.3 Definition and Handling of Critical Information

The operations support domain does not have any specific critical data requirements and uses conventions described in Para. 3.1.3.2, Alert Area.

6.6.3 Header Zone

The header zone for Operations Support utilizes the conventions as described in Para. 3.1.2, Header Zone.

6.6.4 Status Zone

The Operations Support function may require multiple windows to be open simultaneously. Consequently, this domain requires a smaller status area and larger work zone. The section below describes Operations Support specific status area and alert area conventions.

6.6.4.1 Status Area

The following components are examples of the content that could be displayed in the status area.

6.6.4.1.1 Activities Scheduled

A schedule of activities may not be necessary for system, security, and database administration operations; however, a schedule of activities is an alternative, if needed. A training activity schedule could be included in the status area, and would follow the conventions defined in the Contact Operations domain.

6.6.4.1.2 Resource and Activity Status

The following are two alternatives for providing resource and activity status:

Alternative 1 - Use of hierarchical icons. Using hierarchical icons would provide a more accessible option to selected/defined areas of importance. An example of functions that could be accessed via icons includes: Problem Analysis/ Tracking, Network and Security.

Alternative 2 - Use of graphics or lists. A graphical format would provide more visual, and consequently more efficient analysis capability. A variation is to provide system/process information in a list format that allows for more status in the space provided (as opposed to graphical format).

6.6.4.2 Alert and Message Area

The alert and message area follows conventions described in Para. 3.1.3.2, Alert Area. Content of alerts and messages can include: security alarms, hardware/software problems/updates, networking problems/updates, database problems/updates and system feedback. Table 6.10 includes examples of alarms, warnings, and events.

Table 6.10. Operations Support Alarms, Warnings, and Event Examples

| Criticality | Date/Time | Source | Text |
|-------------|--------------|--------|---------------------------------|
| E | 149/00:23:00 | system | Password for user 'smith' added |
| E | 149/00:20:00 | system | User 'smith' created |
| E | 149/00:19:00 | system | Backing up filesystem '/usr' |
| A | 149/00:18:00 | system | Security Alert |

6.6.5 Toolbar

Listed below are the Operations Support specific conventions that apply to toolbars:

- The toolbar location is not critical: it can be placed below the header bar and above the status area, below the status area, or at the bottom of the screen. The toolbar includes a pull-down menu to be used for navigation or entry point into the operations support functions. There is no operational reason to prevent the pull-down menu from temporarily covering the status area if an option is chosen which does so (first case).
- The toolbar includes the functionality to select one of the following options: File, System Administration, Security, Database and Training/Simulation using a 'file menu' approach.
 - a) The **File** option includes access to system functions such as system prompt, print, and

exit. The **system prompt** option is to provide a system window for command line entry.

The **print** option is to provide a mechanism for printing the work zone (header and all windows) or a specific window. The **exit** option is to exit the operations support area.

- b) The **System Administration** option acts as an entry point into the system administration specific functions to include the following options: Main Sys Admin, SW Mgmt, HWw Mgmt, Security, User Mgmt, Network Mgmt, Storage Mgmt, Problem Mgmt, Performance Mgmt, Printer Mgmt, Processes Mgmt, Backup/Restore and Shutdown.
- c) The **Security** option provides an entry point into the security administration specific functions to include the following options: C2 (a level of DoD security) Audit, Alarm Monitoring, Firewall Configuration, Guardwall Configuration.
- d) The **Database** option provides an entry point into database management specific functions to include the following: Database (COTS Product), Utilities and Problem Tracking/Reporting.
- e) The **Training/Simulation** option provides an entry point into the training/simulation specific functions, to include the following options: Plan Sim, Run Sim, Playback Sim, and Update Student Database.
- f) The **Help** option provides application level help for all of operations support.

- For all domains, it is important to setup user limitations based on the operations concept. Therefore, depending on how ‘user permissions’ are set up, different functions of the Operations Support toolbar may be grayed out (insensitive) if the user does not have access.

6.6.6 Operations Support Specific Conventions

All system and security administration windows need access to a system prompt feature (under the file menu option) which when activated, displays a system prompt area (scrollable multiple line input field) at the bottom of the window.

In order to minimize potential operator error, for all windows (to include child windows), it is a preferred convention to use combo boxes, instead of input fields. This convention allows an operator to either select or type an option minimizing the potential for operator error. In addition, whenever possible, menus (file option, drop down, etc.) are used instead of push buttons. These GUI techniques maximize functionality while minimizing the number of windows required to perform a particular task. As a result, this convention is beneficial to both a novice and an expert user.

There are no Operations Support specific conventions for the database and training windows. The Operations Support domain utilizes the conventions described in Para. 1, Overview, through Para. 5, Help.

6.6.7 Operations Support Windows

6.6.7.1 System Administration Windows

Listed below are the Operations Support specific functions that apply to System Administration.

6.6.7.1.1 System Administration Main Window Variation 1, Variation 2, Variation 3, Variation 4

Listed below are the specific functions that apply to the System Administration main window:

- There are four views within this window. The default view is accomplished using icons and labels; however, a view exists for icons only, labels only, and one using toggle buttons (GUI very similar to the IBM tool). Therefore, Main System Administration, Alternative views 1, 2, 3, and 4 should all be tied to one window with the preferred view being displayed based on operator preference. Under the view menu option, the operator can choose the display option for the window view selected.
- These windows can be used as a type of menu/navigation area for the key functions within system administration. The functionality of these windows is based on IBM's tool. The GUI conventions are based on a combination of the Sun and HP tools. The windows provide the ability to select any of the following functions: Main Sys Admin, SW Mgmt, HW Mgmt, Security, User Mgmt, Network Mgmt, Storage Mgmt, Problem Mgmt, Performance Mgmt, Printer Mgmt, Process Mgmt, Backup/Restore, and Shutdown. A system prompt option (using Scrollable List) is also provided
- This design maximizes the number of windows, but information is presented in a simple well-organized manner. User performance may be improved because of the orderly and clutter-free appearance. From a convention, as well as GUI technique perspective, the System Administration Variation 1, 2, 3, and 4 windows are preferred over the System Administration Variation 5 window.

6.6.7.1.2 System Administration Main Window Variation 5

The design for this window includes all of the functionality included in the previous System Administration windows. However, from a GUI perspective, this window uses a file menu only option. This convention minimizes real estate by providing cascading menu options, which minimizes the number of windows the operator must access to perform a task.

6.6.7.1.3 SW Mgmt Variation 1 Window, HW Mgmt Variation 1 Window, User Management Window Variation 1, Users Window

These windows can be used as a menu/navigation area for the key areas. The functionality for these windows is based on IBM's tool. They use push buttons, which provide a drill-down capability to get to the required function. This design maximizes the number of windows, but information is presented in a simple and well-organized manner. User performance may be improved because of the orderly and clutter-free appearance.

6.6.7.1.4 SW Mgmt Variation 2 Window, HW Mgmt Variation 2 Window

This variation minimizes real estate and the number of windows that an operator must access while providing immediate status. For this reason from a convention, as well as GUI technique perspective, the SW and HW Mgmt Variation 2 windows are preferred over SW and HW Variation 1 windows. These windows can be used as a menu/navigation area for the key functions. The windows display status by using drop down menus, file menus, and push buttons. This is a little different than the COTS tools in that it incorporates the following functions into one window: List Software, Install/Update Software, Modify Software, Client Software Management, Database Management, and Configuration Management. As a result, the number of windows required for the function is reduced.

6.6.7.1.5 Add a User Window, Password Window

These windows use input fields and combo boxes to allow the user to select and/or set default information. A submit button is used to apply and process the updates. This design minimizes real estate, the number of windows that an operator must access to perform a task, and minimizes operator errors.

6.6.7.1.6 User Management Variation 2 Window, Modify Groups Window

These windows use combo boxes, input fields, toggle buttons, and push buttons to allow the user to select and/or set default information. The functionality, as well as GUI convention, is modeled after the DEC tool. The design combines several functions into one window thus reducing the number of windows. As a result, these windows have more options/functions than push-button-only windows. This design minimizes real estate through reuse while maximizing efficiency of windows and operator actions. From a convention, as well as GUI technique perspective, the User Management Variation 2 window is preferred over User Management Variation 1 window.

6.6.7.1.7 Secondary Groups Window

This window uses scrollable lists and push buttons to allow the user to add/remove users from a selected group. The scrollable lists provide the flexibility of viewing all the groups without having to open a secondary window. An Add/Remove push button is used to add a group to the specified users' profile. The functionality for this window was modeled after the DEC tool. This design presents information in a simple and well-organized manner. It minimizes the number of actions that an operator must perform thus reducing the chance of operator error.

6.6.7.1.8 Network Management Window

The Network Management window is designed using radio buttons, as well as file menu (for fast path). The functions are consistent with the COTS tools, but the GUI conventions are different. This design combines several network management functions into one window, and minimizes the size of windows while providing the maximum amount of functionality.

6.6.7.1.9 Storage Management Window

The Storage Management window is designed using a drop down menu arrow. The functions are based on the IBM tool. As a function (menu option) is selected, a list box appears within the window detailing additional options/functions, rather than a drill-down capability (additional windows). This

design combines several functions into one window, and minimizes the size of the window while providing the maximum amount of functionality. In addition, the data is organized in an orderly manner with a clutter-free appearance.

6.6.7.1.10 Problem Management Window

This window is built using the same type of design as the storage management window. However, instead of selecting the arrow box, the text would be selected (pull-down menu). This window combines two Problem Management areas, analysis and tracking, in order to minimize the number of windows required to get into any one problem management area. This design provides more efficient use of window real estate, smaller window size, and a maximum amount of data in the window. As a result, the data is organized in an orderly manner with a clutter-free appearance. From a convention, as well as GUI technique perspective, this window is preferred over Problem Management Toggle Button Approach Window.

6.6.7.1.11 Problem Management Toggle Button Approach Window

This window contains the same functions as the problem management window. However, the window uses a variation in GUI conventions. Instead of using pull-down menu, it uses toggle buttons. This design maximizes the number of windows, but information is presented in a simple, well-organized manner. Because the data is organized in an orderly clutter-free format, user performance can be improved.

6.6.7.1.12 Performance Management Window

This window is built using a push button, toggle button, and combo box design. The functionality is based on the IBM tool, but the GUI conventions are different. Two areas, system and network, are combined to minimize the number of windows that the user would have to select. This design presents information in a simple and well-organized manner, which enhances pointer and eye movement requirements and minimizes operator error.

6.6.7.1.13 Print Management Window

This window was designed to utilize both radio buttons and combo boxes. The functionality is based on the IBM tool, but the GUI conventions are different. This window combines three print management areas (print jobs, printer characteristics and troubleshooting), again to minimize the number of windows required to perform a particular print management task. This design minimizes real estate and the number of windows that an operator must access to perform a task.

6.6.7.1.14 Process Management Window

This window uses pull-down menus. The convention appears to be push buttons, but when selected act as pull-down menus. The functionality is based on the IBM tool, but the GUI conventions are different. This window combines four process management areas (resource control, job schedule, subsystems, and accounting). By combining the four functions, multiple windows have been reduced down to one window. This design minimizes real estate and the number of windows that an operator must access to perform a task.

6.6.7.1.15 Backup/Restore Window, Backing Up Filesystem Window

These windows use a combo box approach (difference in the look, rectangle versus arrow). The functionality is based on the IBM tool, but the GUI conventions are different. The Backup/Restore window combines two functions, thus minimizing the number of windows. This design approach minimizes the amount of typing required to perform or select options for a particular task thus reducing operator error. In addition, the data is placed in a simple and well-organized manner, which provides a simple way for the operator to navigate through the system.

6.6.7.1.16 Shutdown/Re-boot Window

This window uses a combo box, toggle on/off, and a display input field. The functionality is based on the IBM tool, but the GUI conventions are different. The combo box allows the user to either select or type the required information. Also depending on the selections of the operator, functions can be activated/deactivated. This window includes an option to broadcast a message warning users of the shutdown/reboot. The message is to be displayed in the alert area of systems affected. The display message is in a format that brings attention to the operator (red, flashing, beeping, etc.). This window combines Shutdown and Re-boot functions which minimizes the number of windows required. The design also provides a clear way of moving through the window, which reduces pointer and eye movement requirements.

6.6.7.1.17 GPS System Administration Windows

The GPS system runs on a Sun Solaris Platform. At this time, the system administrators in the test environment are using Solstice along with command line options to perform system administration activities. It is anticipated that the system administration tool is Solstice or a compatible Sun tool (GUI conventions are consistent with Solstice).

6.6.7.1.18 SBIRS System Administration Windows

SBIRS runs on a Silicon Graphics System Platform. At this time, it is anticipated that the tool for system administration is compatible with the IRIX (operating system for Silicon Graphics) operating system. No analysis has been performed on the IRIX operating system or compatible COTS tools.

6.6.7.2 Security Administration Windows

Listed below are the Operations Support specific functions that apply to Security Administration.

6.6.7.2.1 Security Main Window, C2 Audit Window, C2 Audit Select Report Window

These windows can be used as a menu/navigation area for the key functions. The functionality for these windows is based on a combination of several COTS tools. This combination uses push buttons that provide a drill-down option to get to the required function and multiple windows. This design maximizes the number of windows, but information is presented in a simple and in a well-organized manner. Because data is organized in an orderly and clutter-free grouping, user performance is expected to improve.

6.6.7.2.2. User Specific Report Selection Window

This window uses a scrollable list box, combo box, and push buttons. The functionality and GUI conventions are based on several COTS tools. The scrollable lists provide the option of having all data accessible on one window. The combo boxes minimize typing requirements and provide selectable options. This design provides clear indication of inter-relationships, which reduces the number of actions that an operator must perform thus minimizing the potential for operator error.

6.6.7.2.3. C2 User Report Window

This window produces a formatted report using output fields, scrollable list boxes, colored text, and push buttons. The data is gathered from the Audit Log information. If there is a problem area or failed status within the report, the text utilizes color status by turning red to indicate the problem. This design presents information in a simple and well-organized manner. Note: Colored text may be difficult to read, therefore, alternative color status (i.e., color borders, indicator borders, etc.) coding methods should be considered first if available.

6.6.7.2.4. Alarm Monitoring Window

This window uses a file menu, hierarchical icons, a scrollable list box, and push buttons. The functionality is based on a security alarm monitoring COTS tool. The window is designed to show status in the window area while using the menu as navigation point. If an alarm has occurred for either network (firewall, routers, bridges) or server, the icon buttons are to have a red border. The detail on/off button can be selected for either area, and information is to be displayed below the buttons in the details area. If additional information is required, a report can be selected from the menu area. All alarm messages are also displayed in the alert area and an email is to be sent to the security administrator. The status area allows the operator to access data without having to open additional windows. As a result, a visual awareness of alarm status area is provided. This design minimizes real estate and the number of windows that an operator must access to perform a task.

6.6.7.2.5. Firewall Configuration Window

This window is designed with a push button and file menu approach. The functionality is based on firewall COTS tool. The file menu option provides fast-path access into a particular area that reduces the number of windows. This is a good option for a more experienced user. The push button would allow a less experienced user to step through the windows. This design provides functionality for both types of users. It is similar to the Alarm Monitoring Window; however, it does not provide a status area.

6.6.7.3. Database Administration Windows

6.6.7.3.1. Database Management Main Window, Open/Close Database Change Request (DBCR) Window, DBCR Search Results Window, DBCR Transfer Window, Database Utilities Window, Move To Operations Window

The Database windows were designed to minimize real estate by providing ‘pull-down menu arrow’ options, toggle buttons, push buttons, and input/output fields. This minimizes the number of windows that an operator must access to select a task. In addition, the data is presented in a simple and well-organized manner minimizing pointer and eye movement requirements.

6.6.7.3.2. GPS Database Windows

From initial investigation, it has been determined that GPS plans to use Oracle as the COTS database. It has not been determined if a front end GUI needs to be built to access the COTS database.

6.6.7.3.3. SBIRS Database Windows

From initial investigation, it has been determined that SBIRS plans to use Sybase as the COTS database. It has not been determined if a front end GUI needs to be built to access the COTS database.

6.6.7.4. Training/Simulation Windows

6.6.7.4.1. Training: Run/Control Simulation, Plan Simulation, Playback Simulation, Update Student Database Window

The Training windows were designed to minimize real estate by providing tabbed pages. This GUI technique minimizes the number of windows that an operator must access to perform a task, maximizes reuse and efficiency of windows, minimizes operator actions, and presents information in a simple and well-organized manner.

6.6.7.4.2. Import/Edit Script Window, Save Script Window, Save Initial Conditions Window, Save Sim Window

These windows were designed to use or be consistent with the standard import/save window. Data is placed in a simple and well-organized manner, which minimizes operator error.

6.6.7.4.3. Initial Condition Window

This window contains the ability to set the initial conditions of the satellite before a simulation begins. The GUI techniques used include push buttons, option menus, scrollable lists, and combo boxes. This design provides a clear indication of interrelationships, which reduces the number of actions that an operator must perform.

6.6.7.4.4. Insert Anomaly Window

This window contains the ability to insert an anomaly real-time during a simulation by using combo boxes and push buttons. This design provides a clear indication of interrelationships, which reduces the number of actions that an operator must perform.

6.6.7.4.5. Abort Window, Delete Student Record Window

These windows act as warnings by providing messages to confirm selected actions prior to execution. The design uses the standard Motif ‘warning’ type window conventions.

6.6.7.4.6. Student Record Window

This window contains the ability to create or edit a student’s simulation record by using combo boxes, toggle buttons, input fields, and push buttons. This design minimizes real estate and the number of windows that an operator must access to perform a task.

6.6.7.4.7. GPS Training Windows

The GPS program has designed and developed a high fidelity GUI training/Simulator. The GPS simulator uses some of the following GUI techniques: push buttons, scrollable lists, input/output fields, toggle buttons, and drag and drop. Based on initial investigation, it appears as if the functionality for the GPS simulator is similar (with added options/function) to the windows designed. In addition, the conventions used in developing the GUI appear to be consistent with the conventions presented in this document

6.6.7.4.8. SBIRS Training Windows

The SBIRS program is using a Lockheed Martin Mission Systems (LMMS) software developed tool called Basic Outboard Software Simulator (BOSS) to do basic simulation/training. The BOSS program provides command responses while generating telemetry. To accommodate additional training/simulation requirements for SBIRS, it is anticipated that a GUI set of windows needs to be designed/developed to run with BOSS and/or BOSS enhancements. However, at this time those interfaces have not been developed.

Appendix A - Definitions

ACCELERATOR KEY – Consists of a modifier key (<Shift>, <Alt>, or <Ctrl>) and one other key. This is used by experienced users for quick and consistent access to certain functions or actions.

ALARM - The most critical alert category. Indicates that a condition exists which requires immediate operator action.

ALERT - Indication of a condition regarding people, systems, or the mission, categorized into alarms, warnings, events, and informational messages. Alarms, warnings, and events must be explicitly acknowledged. Informational messages do not require acknowledgment.

DRILL DOWN – Method of invoking (gaining access to) another window that provides more detailed information on the component or icon selected.

EVENT - An alert that notifies the operator of conditions which require explicit acknowledgment, but does not have the criticality of a warning or an alarm.

EXPLICIT FOCUS - A keyboard focus model that sends keyboard actions to the window or component that was specifically selected by a mouse button or keyboard event.

FIELD – A rectangular construct, wider than high, that appears sunken (light colored border [(edge)] on bottom and right side with dark color [(dark gray)] on top and left side). An area where output data is displayed or input data is entered.

ICONIFY - To collapse a window into an icon representation of the window. This is distinct from minimizing a window.

IMPLICIT FOCUS - A keyboard focus model that sends keyboard actions to the window or component that the mouse pointer is over (no explicit selection action is needed).

MESSAGE - An informational notice which does not require acknowledgment by the user.

MINIMIZE - Procedure to make a window as small as it can be without being closed while still displaying some or all of its contents meaningfully. This is distinct from collapsing or iconifying a window.

MNEMONIC – Identified by underlining a single character and normally used in menu titles and menu options. When the construct (menu or other) has input, focus keyboard entry of the mnemonic executes the selection.

ON-LINE SYSTEM - A system that is currently active.

OFF-LINE SYSTEM - An inactive system, typically a redundant backup system.

WARNING - An alert that indicates a condition that may escalate to alarm criticality. This

requires operator acknowledgment.

WORK ZONE - The area not used by the header, the screen control/toolbar, and the status zone alert areas. The area is used for placement of application/domain windows to support the tasks described in the Functional Task Analysis (FTA) (Lockheed Martin Mission Systems, 1998).

Appendix B – Acronyms

| | |
|--------|--|
| AFSCN | Air Force Satellite Control Network |
| AIAA | American Institute of Aeronautics and Astronautics |
| AIX | Advanced Interactive Executive |
| ANSI | American National Standards Institute |
| ARTS | Automated Remote Tracking Station |
| ASTRO | Automated Scheduling Tools for Range Operations |
| BOSS | Basic Outboard Software Simulator |
| C2 | A level of DoD security |
| COTS | Commercial Off The Shelf |
| CPU | Central Processing Unit |
| DBCR | Database Change Request |
| DEC | Digital Equipment Corporation |
| DII | Defense Information Infrastructure |
| DoD | Department of Defense |
| DSCS | Defense Satellite Communications System |
| DSIS | Defense Communications System/Satellite Control Facility Interface System |
| DSP | Defense Support Program |
| FEP | Front End Processor |
| FTA | Functional Task Analysis of the Air Force Satellite Control Network Satellite Control Operations (Lockheed Martin Mission Systems, 1998) |
| GOTS | Government Off The Shelf |
| GPS | Global Positioning System |
| GUI | Graphical User Interface |
| HCI | Human Computer Interface |
| HCISSO | Human Computer Interface for Satellite System Operations |
| HMI | Human Machine Interface |
| HP | Hewlett Packard |
| HP UX | Hewlett Packard's Unix operating system |
| IBM | International Business Machines |
| IRIX | Operating system for Silicon Graphics |
| IRO | Inter-Range Operations |
| IRON | Inter-Range Operations Number |
| JTA | Joint Technical Architecture |
| LMMS | Lockheed Martin Mission Systems |
| MCC | Mission Control Complex |
| MS | MicroSoft |
| MUE | Mission Unique Equipment |
| OOH | Orbital Operations Handbook |
| OPSCAP | Operational Capability |
| OSF | Open Software Foundation – produced OSF/Motif Style Guide Rel. 1.2 |

| | |
|-------|--|
| RGF | Remote Ground Facility |
| RFI | Radio Frequency Interference |
| RSC | Research, Development, Test & Evaluation (RDT&E) Support Complex |
| RTS | Remote Tracking Station |
| SBIRS | Space Based Infrared System |
| SOC | Satellite Operations Center/Complex |
| SSP | Satellite Support Plan |
| STK | Satellite Tool Kit |
| SV | Space Vehicle |
| TAFIM | Technical Architecture for Information Management |
| US | United States |

Appendix C – References

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SMC Standard Improvement Proposal

INSTRUCTIONS

1. Complete blocks 1 through 7. All blocks must be completed.
2. Send to the Preparing Activity specified in block 8.

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|---|--|-------------------------|
| SMC STANDARD CHANGE RECOMMENDATION: | 1. Document Number | 2. Document Date |
| 3. Document Title | | |
| 4. Nature of Change (Identify paragraph number; include proposed revision language and supporting data. Attach extra sheets as needed.) | | |
| 5. Reason for Recommendation | | |
| 6. Submitter Information | | |
| a. Name | b. Organization | |
| c. Address | d. Telephone | |
| e. E-mail address | 7. Date Submitted | |
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